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<p>This study describes the development of the Generalized Explanatory Base Operating Support (GEBOS) model. GEBOS is an interactive computer model that enables Air Staff-level manpower planners to determine the impact of a variety of changes to BOS manpower or aggregate workload. The model uses linear programming techniques to solve relationships between BOS functional categories and aggregate workload indicators.</p> <p><u>report</u> The reprot covers data collection, the statistical analysis of manpower and workload, a description of the linear programming methodology developed, examples of how results may be used, and GEBOS model documentation. Included in the research effort is an investigation of the relationships between primary mission activities and BOS workload indicators. A prototype mission model was developed showing the feasibility of extending the model to include mission relationships. A plan for implementation of GEBOS Air Forcewide and inclusion</p>					
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Development of a Generalized Explanatory Base Operating Support (GEBOS) Model

FINAL REPORT

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January 1980

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SECTION 1

OVERVIEW

This final technical report on the development of a generalized explanatory base operating support (GEBOS) model covers applied basic research undertaken by General Research Corporation (GRC) from 1 June through 30 November 1979. Project work has been funded by the Air Force Office of Scientific Research (AFOSR), under Contract F49620-79-C-0146, in behalf of the Directorate of Manpower and Organization (AF/MPM), Headquarters, United States Air Force. The focus of this work has been on full development of the GEBOS model for three test commands and on prototypical extension of the model concept to encompass selected mission impacts of base operating support (BOS) changes.

1.1 BACKGROUND

The research documented here is an outgrowth of earlier GRC work addressing the feasibility of deriving and applying aggregate BOS workload/output indicators for use as management tools at the Air Staff level.¹ This earlier work concentrated on the derivation of aggregate workload and manpower relationships for the BOS program elements of Air Training Command (ATC), Strategic Air Command (SAC), and Tactical Air Command (TAC).² It was undertaken in recognition of a need for more precise means of quantifying BOS outputs and the manpower associated with varying output levels. Major results included:

- Compilation of a pilot workload indicator data base to support time series and cross-sectional analyses of

¹E. J. Schmitz, R. Somers, and T. Vassar, Pilot Program to Develop Aggregate Base Operating Support Workload Indicators for Use in Air Staff-Level Manpower Management, Report 1059-01-79-CR, General Research Corporation, March 1979.

²Respectively, program elements 85796, Base Operations (Training); 11896, Base Operations (Offensive); and 27596, Base Operations.

manpower and output relationships within BOS functional categories.¹

- Establishment, through objective experimentation, that useful BOS workload indicators could be derived to support Air Staff-level manpower management and presentation of requirements to the Office of the Secretary of Defense (OSD), the Office of Management and Budget (OMB), and the Congress.
- Preparation of a concept and implementation plan for an Air Force-wide Aggregate Workload Indicator System.
- Development of a prototype GEBOS model which could use manpower workload-indicator relationships to:
 - Estimate the impact of a given increase or decrease in manpower on projected outputs or capabilities by function and major command.
 - Project the manpower impact of a given workload increase or decrease by function, program element (PE), and command.
 - Explain the apparent interdependency of various workload measures, including support-on-support relationships implicit in BOS.

As addressed below, this most recent effort has been concentrated on refinement of the GEBOS model to enhance its usefulness as an Air Staff management tool.

¹Administration; retail supply operations; maintenance of installation equipment; other base services; morale, welfare and recreation; other personnel support; and bachelor housing operations. These functional categories are defined by OSD and are made up of aggregations of Air Force functional accounts.

1.2 OBJECTIVES

Research objectives and associated tasks have been as follows:

- Data collection and analysis:
 - Identify additional data requirements necessary to continue development of the current prototype GEBOS model.
 - Update the pilot workload indicator data base with the most current data on:
 - Manpower authorizations by base, function, military/civilian status, and PE.
 - Workload, as detailed in various standardized reports.
 - Specialized workloads as detailed in responses from SAC, TAC, and ATC to requests for specific data.
 - Refine gross workload indicators to more reliably reflect workload data content and physical outputs.
 - Refine and update previously derived factors using current and, where appropriate, annualized data.
- Full development of the GEBOS model for test commands:¹
 - Continue development of the GEBOS model based on concise systems and operations research and analysis to assure accurate and consistent model performance.
 - Incorporate precise workload indicator/manpower interrelationships into the BOS model to realistically simulate the complex impact of BOS manpower adjustments and associated changes.
 - Maintain throughout the model refinement process a prime focus on real-world interaction of data elements,

¹SAC, TAC, and ATC.

on generating meaningful model output, and on substantive manpower/workload relationships in a form usable and meaningful to Air Staff and higher authorities.

- Provide an operating GEBOS model, covering the test commands, on a commercial computer system with documentation to include a system description and an updated copy of the data collected for analysis.
- Exploration of GEBOS model extension to mission impacts:
 - Initiate research on correlation of mission impacts with BOS changes.
 - Identify key mission output measures; review existing reports, project outcomes, and data that deal with related issues; and designate the test command(s) selected for mission impact research extension.
 - Collect additional data on primary mission activity for correlation of the impact of BOS changes to include alternative measures of mission effectiveness/readiness.
 - Investigate mission manpower and primary mission activity in detail for the selected operational command.
 - Analyze aggregate BOS relationships to primary mission capability, particularly in such BOS areas as supply, equipment, and maintenance; focus on determining the validity and consistency of such relationships and select the most usable form of these relationships for modeling test command mission/BOS manpower/workload relationships for extension to other commands.
 - Prepare a draft plan for incorporation of an extension to mission relationships in the GEBOS model.

- Provide the user activity (HQ USAF/MPM) a demonstration of the prototype mission impact GEBOS model using a commercial computer system.

This report will detail the accomplishment of the objectives and tasks enumerated above.

1.3 SUMMARY OF ACCOMPLISHMENTS

1.3.1 Data Collection and Analysis

Data needs to continue GEBOS model development were identified to AF/MPM and discussed with Air Force Management Engineering Agency (AFMEA) personnel in June 1979. Manpower authorizations and workload data for FY78 were obtained from AFMEA, the Air Force Accounting and Finance Center, the Air Force Data Services Center, the three test commands, and certain other sources. These data were used to update the pilot workload indicator data base which was reactivated on the Computer Sciences Teleprocessing System (CSTS) in July 1979. Section 2.1 and Appendixes A through E provide details.

Analysis efforts completed included:

- Comparison of FY78 manpower and workload data to that previously obtained for FY77.
- Identification of those FY78 workload indicators highly correlated with related functional manpower.
- Development of FY78 GEBOS model production functions through multivariate regression analysis, including modification of estimating equations to incorporate "best" predictive variables.
- Analysis of workload intercorrelations to develop workload interrelationship equations for the GEBOS model.

Section 2.2 is an extended discussion of this work, while Appendixes B through E document supporting quantitative data.

1.3.2 Full Development of the GEBOS Model for Test Commands

Significant achievements were made in the continued development of the GEBOS model. In its prototype form,¹ it served fundamentally as a descriptive model which associated specified changes in BOS manpower (by functional category) with changes in a set of primary workload indicators.² Using simultaneous production function equations (with coefficients derived through stepwise multivariate analysis of FY77 workload and manpower data from the pilot workload indicator data base), it allowed for the "support-on-support" change implicit in the BOS sector of installation operations. Its potential utility was for quantification of estimated changes in output to support budget requests/reviews or to estimate the workload capability impact of directed reductions (given a constant production function). Specific limitations of the prototype included the following:

- Absence of a suitable basis for distributing (by functional category) manpower changes associated with a given workload change.
- Limited options for specifying manpower changes (i.e., total manpower or single function only).
- Changes in manpower across functional categories could only be distributed on a pro rata basis.
- Interrelationships to account for "support-on-support" were limited only to the three population variables.²
- Descriptive capability was limited to only seven non-population primary workload indicators.
- Base closures (or openings) could not be treated in combination with other postulated changes.

¹Schmitz et al., op. cit.

²Base population, travel transactions, supply transactions, supply item records, vehicle inventory, vehicle mileage driven, total population supported (including dependents), military population, weighted rations served, and visiting officer quarters.

The current operational version of the GEBOS model has been designed to overcome these limitations. Its full capabilities were demonstrated to AF/MPM personnel on 14 November 1979 using the CSTS commercial time-sharing services. Specific features include:

- Use of linear programming methodology to solve an expanded simultaneous equation set.
- Capability to account for interrelationships among all primary workload and population variables.
- Incorporation of production functions for additional descriptive workload indicators even though not used as primary variables due to lower significance in multivariate analyses.
- Complete user flexibility for input of both manpower (by functional grouping) and primary workload variables.
- Consideration of interrelationships among all primary workload indicators in accounting for "support-on-support" relationships.
- Integration of capability to exercise base closing/opening options in conjunction with other BOS changes.

The adoption of linear programming methodology represents the most significant new feature of the GEBOS model and provides a capability to use the model in a normative (or optimizing) as well as a descriptive mode. As it presently operates, the objective function maximizes workload (output) capability and minimizes slack functional manpower for a given manpower change or it minimizes BOS manpower (and functional slack) for a given workload change. The coefficients of the objective function assume equal value for all functional capabilities; however, by relaxing workload interrelationship constraints and applying judgmental weights to functional indicators on manpower, the model has the potential for providing functional manpower/workload distributions consistent with user priorities. Full utilization of this latter capability will require some further experimentation and development.

At present, the GEBOS model also has rudimentary capability for use as a predictive model for manpower programming, since user input changes in supported mission populations can be used to generate BOS changes by workload and function. In this form, however, the model does not differentiate types of workload generated by different primary mission units. This latter capability needs fuller development as will be discussed later when treating developmental work on the GEBOS model mission impact capability. Sections 3.1 and 3.2, augmented by Appendixes F and G, provide full detail on basic GEBOS model design and operation.

Model verification and validation have been a key challenge during this research period. If the model is to be used with confidence for explaining/justifying BOS manpower and workload indicator relationships to higher authority, for estimating functional distributions of BOS manpower and/or workload changes, or, eventually, as a manpower programming and allocation tool, it must, within acceptable limits, approximate the results of detailed standards applications at major command level. Four principal approaches to the determination of model validity have been identified.

- Internal verification of computational methodology using existing data.
- Validation through application of historical data.
- Validation through comparison with direct application of standards and guides.
- Validation through comparison with standard/guide application resulting from programmed mission (force structure) changes.

Internal verification of the current GEBOS model has been successfully completed; given either FY78 manpower authorizations or workload indicators, the model accurately replicates the workload and manpower data used for derivation of the functional category production functions.

As an initial validation step, FY77 production functions have been used with FY78 manpower and workload data and FY78 production functions have been used with FY77 manpower and workload data. In both cases, there were frequent differences of 10% or more between actual and predicted manpower/workload in certain functional categories. While these differences are to be expected due to year-to-year changes in productivity (generally, productivity increases were indicated) and fall within expected limits, this process cannot be considered a precise validation technique. It does, however, highlight the desirability of annual update of regression coefficients used in production functions.

Certainly validation through direct standards/guides application is a preferred method. Because of the workload it would have imposed on Air Force activities, and certain technical complications, a full validation of this type was not undertaken during this research period. A trial priceout of SAC supply standards was completed and established that, allowing for assumptions which had to be made, the GEBOS model prediction for the retail supply operations functional category replicated actual standards applications within reasonable limits.

The fourth approach to validation, comparison with standard/guide application resulting from programmed force structure changes should provide the most acceptable basis for validation. This approach should be undertaken when full mission/force structure capabilities have been integrated in the model. At that point, the model can be tested against actual force structure changes which have been entered in command manpower data system unit authorization files. Once satisfactory explanations for differences have been developed and appropriate adjustments made, the GEBOS (mission) model can be effectively extended for use as a programming and allocation tool.

Section 3.3 and Appendixes H and I provide additional details on validation.

1.3.3 Exploration of GEBOS Model Extension to Mission Impacts

Extension of the GEBOS model to deal with the direct mission impacts of BOS manpower and workload capability changes has two major objectives:

- To provide a means for relating BOS changes quantitatively to changes in war-fighting capability.
- To permit the GEBOS model to be used as a force-structure related manpower programming and allocation tool.

During this research period, various mission output measures with potential for GEBOS use in quantifying mission effectiveness/readiness were identified. The conceptual approach identified as preferred has the following features:

- Correlating peacetime mission capability measures (e.g., flying hours, training sorties, UE aircraft by mission design series, etc.) and mission unit manpower to primary BOS workload indicators such as supply transactions, fuel consumption, etc.
- Incorporation of mission relationships in the existing linear programming model set of constraint equations.
- Adjustment of BOS manpower and primary workload indicators as a function of changes in specified force units and their associated workload/capability measures (programming mode).
- Assessment of force unit/capability impact of BOS manpower changes subject to user input priorities/constraints on distribution of force capability changes.
- Linking of peacetime mission unit workloads to wartime mission capabilities through specific unit capabilities as identified in the designed operational capability statement.
- Quantification of final war-fighting capability changes in terms of sorties and/or flying hours planned for application under a given wartime scenario.

Preliminary analysis of BOS/mission workload relationships was conducted using TAC as the test command and a prototype GEBOS (mission) or GEBOS-M model was demonstrated for HQ USAF/MPM representatives on 28 November 1979. Section 4 and Appendix J provide details to include a draft plan for full development of the GEBOS-M model. Also developed in Section 4 is a concept for alternative GEBOS-M model operation where mission capabilities are held constant and selected production function adjustments are made to account for BOS changes.

1.4 PROFESSIONAL PERSONNEL ASSOCIATED WITH THE RESEARCH EFFORT

Mr. Edward J. Schmitz, senior analyst, served as principal investigator and project manager throughout this research period (June through November 1979). Study team members consisted of Mr. W. Roger Johnson, senior analyst; Mr. Henry C. Alberts, principal scientist; and Dr. Thomas B. Vassar, consultant in the areas of mathematical modeling and computer programming.

GRC management oversight was provided by Mr. Norvin E. Rader, senior analyst, and Mr. Jack I. Posner, principal scientist and Associate Director for Management and Organization. Mr. Richard L. Somers, principal scientist and Vice President/Director of Resource Management Operations provided senior supervision, made technical contributions throughout the period, and participated as co-author in the preparation of this report.

SECTION 2

DATA COLLECTION AND ANALYSIS

This section summarizes the principal activities and findings of the data collection and analysis effort. The detailed results and supporting information can be found in Appendixes A through E.

2.1 DATA NEEDS AND COLLECTION ACTIVITIES

A majority of the FY78 data required for continued development of the GEBOS model was provided by AFMEA. All manpower authorization data and many workload indicators were made available to GRC and transmitted via magnetic tape to the Computer Sciences Teleprocessing System (CSTS) in August 1979. AFMEA's data collection activities greatly reduced the data collection, data entry, and preliminary data processing and transformation effort required by GRC prior to beginning analysis.

In addition to workload indicator data provided by AFMEA, several other workload indicators were collected. These included additional accounting and finance data, vehicle data, detailed supply data, air traffic operations data, and various other base-level workload indicators. These additional indicators and their sources are listed in Appendix A which also shows the data base format. A magnetic tape with all data was delivered to AF/MPM on 6 December 1979.

There were three reasons for GRC's additional data collection activities:

- Several primary principal functional indicators were not collected by AFMEA, but were available. Where possible, GRC sought to duplicate the primary indicators used in its development of the FY77 equations.
- Additional descriptive indicators were sought. GRC wished to expand the indicator data base to include additional indicators that may not be the best functional predictors, but would enhance the model's descriptive capabilities.

- Some limited analysis of workload variability was sought. Complete annualization of data was not possible, but some duplication of the data collected by AFMEA permitted some assessment on the variability introduced by using monthly rather than annual data.

There were several findings with respect to the data collection effort.

First, the workload indicators of principal interest for model development were all available. Most indicators were comparable with data from FY77. There were minor changes in accounting and finance data and some detailed supply item record data, but otherwise definitions remained the same.

Complete annualization of data is not possible due to the manual nature of the data collection process. Many workload indicators, such as supply and vehicle data, are maintained in base-level detail for only a limited time. It is essential that workload data be collected regularly in a timely fashion for developing annualized data. Also, the manual data extraction, data entry, and data validation procedures would be prohibitively time consuming for monthly indicator data. Comparability of manpower and non-annualized workload data was achieved by matching end FY78 manpower with September 1978 workload data wherever possible.

Where annual data were available, principally for accounting and finance indicators, there were two findings. Indicators that primarily measured population quantities (leave and pay accounts civilian pay records) showed very little monthly variation. Indicators that measured transactional data such as travel transactions and transactions audited showed monthly workload fluctuations on the order of 10%. Therefore, transactional data variability could be reduced by smoothing workload over a period of months.

2.2 DATA ANALYSIS

A variety of data analysis efforts was accomplished as part of model development. The principal findings are summarized in this section.

The manpower and workload changes between FY77 and FY78 are described in Appendix B. Manpower levels again declined for SAC and TAC, while ATC increased slightly with the addition of Maxwell AFB. TAC experienced a 15.6% decline in BOS manpower.

Manpower changes by function varied considerably across commands. SAC manpower declined in all functions. TAC manpower also declined in all functions, but most dramatically in maintenance of installation equipment. ATC manpower exhibited no consistent pattern of increase or decline.

The only anomaly that significantly affected model coefficients was the change in total population supported. Total population supported increased considerably for both SAC and TAC, while it declined substantially for ATC. The indicator definition (from the Domestic Base Factor Report) did not change between FY77 and FY78, but the substantial indicator variations indicate command reporting procedures may have changed.

Many workload indicators were again found to be highly correlated with functional manpower for FY78. For those indicators comparable to FY77 indicators, 24 out of 61 had higher correlations in FY78. However, most correlation changes were relatively small, and similar patterns of significance were obtained. The results are detailed in Appendix C.

The FY77 production functions were recreated for FY78. The results are described in Appendix D. Of the 20 equations, 19 proved to be significant (R^2 statistics), with only SAC bachelor housing operations providing a poor fit; and 26 out of 31 workload indicators were significant (t statistic).

The FY77 equations had higher R^2 values than FY78 in 16 out of 20 cases. This probably indicates a selection bias in favor of the FY77 equations. The indicators that predicted the best for FY77 do not necessarily fit the best for FY78. Also, multicollinearity declined in FY78. The workload indicators increased in significance (t statistic) in 14 out of 31 cases, despite generally lower overall equation accuracy (R^2 statistic).

Workload coefficients generally declined between FY77 and FY78. Only 7 out of 28 directly comparable indicators showed a coefficient increase. Out of 20 equations, 15 showed an increase in the constant or fixed manpower term. The implications of these findings on manpower productivity are further discussed under validation.

The development of the FY78 production functions is also described in Appendix D. Four criteria were used in the development of the FY78 manpower/workload equations:

- A high degree of correlation, fit, and explanatory significance.
- Comparability to FY77 results.
- Inclusion of different types of measures.
- A relationship to other workload indicators.

Indicators were selected that had a significant correlation with manpower. Where multiple indicators were present in the same equation, all were required to have a significant independent relationship with manpower (t statistic).

However, statistical significance was not the only standard for developing equations. Where two similar workload indicators were available, the one comparable to the FY77 indicator was used. This facilitated comparison of production functions with the previous year.

An effort was made to include different types of workload in multiple regressions. For example, in SAC an equation was developed that used vehicles and mileage, rather than simply one or more vehicle indicators. Expansion of the variety of indicators permits the model to have impact in many different areas.

Final consideration was given to the workload indicator's relationship to other workload indicators. The model described in Section 3 requires relationships between workload indicators to achieve balanced workload changes. Preference was therefore given to indicators that could be shown to be interrelated.

For other base services; morale, welfare and recreation; and other personnel support, the same workload indicators were used as in FY77. For other base services, this was total population supported. For morale, welfare and recreation, the indicator was military population for SAC and TAC. ATC used military population and student population as multiple morale, welfare and recreation workload indicators. In other personnel support, all three commands used total population supported and weighted rations served as the variable workload indicators. SAC was again found to require a separate additive manpower factor for missile bases.

The administration and bachelor housing operation indicators were changed somewhat from FY77. Administration again used base population and travel transactions as the principal indicators. However, in FY77 travel transactions was estimated as a proportion of total transactions due to colinearity problems with base population. In FY78, the intercorrelation of travel transactions and base population had lessened so that the travel transactions coefficient could be estimated directly rather than as a proportion. For bachelor housing, the square feet of dormitory space proved to be a better overall indicator than visiting officer quarters had been in FY77.

New workload indicators were used in the retail supply operations area. There are many different workload indicators available in the supply area. They tend to be highly interrelated, and the selection of the best indicators for a particular year depends to a degree on the variability present in a given year's data. Supply transactions were selected for ATC, supply item records and aviation fuel consumption for SAC, and total transactions processed for TAC.

For maintenance of installation equipment, the SAC coefficients were generally similar to FY77. SAC used a combination of military vehicle types with total vehicle mileage. ATC proved to have a significant estimator in FY78, total number of vehicles. In FY77, it was not possible to estimate an indicator due to underreporting of contract manpower. Contract manpower reporting has improved, but still appears to be underreported for several ATC bases. TAC indicators included aircraft tractors and equipment transactions.

Workload interrelationship analysis was also a major analysis activity in the development of GEBOS. The use of workload interrelationships in the model is discussed in Section 3. The detailed findings of the workload interrelationship analysis are presented in Appendix E.

SECTION 3

THE GEBOS MODEL

The major effort under this research contract has been the full development of a generalized explanatory base operating support (GEBOS) model. This model integrates the results of analyses that have been performed on aggregate BOS workload indicators into a unified system that permits the user to quickly estimate the impact of a large number of manpower or workload changes. The current GEBOS model allows the user to:

- Specify manpower changes to one or more commands (for the three test commands).
- Change either manpower or workload for a command.
- Combine manpower changes with base openings and closings.
- Determine the workload impact of specific manpower distributions.
- Specify only aggregate manpower changes with distribution of changes determined by the model.
- Specify changes to selected functional categories with the impact on other functions and workload determined by the model.
- Determine the BOS requirements and functional distribution for a change in mission population.
- Compute the manpower impact of changes in primary workload indicators.
- Determine the military/civilian distribution of manpower changes in BOS.
- Determine the impact of manpower and workload changes on a large number of additional descriptive indicators.

In addition to performing all these different types of computations for the user, GRC has developed a flexible and sophisticated

computation and display system that can readily be adapted to all Air Force commands, permits a large variety of display and computational changes, and can be modified to include mission impacts in the future.

3.1 MODEL DESIGN

As indicated in Section 1.3.2, the current GEBOS model design was based on a prototype developed as a product of earlier research on aggregate BOS workload indicators. The prototype was conceived as an explanatory model which would permit the "impacting" of BOS manpower changes in terms of reduced or increased support workload capabilities. It was (and still is) envisioned that in its explanatory mode of operation, the GEBOS model would give the Air Staff a capability to:

- Define the estimated impact of Five Year Defense Program (FYDP) BOS changed by OSD-established functional categories.
- Justify BOS requirements to OSD, OMB, and the Congress in terms of functional workload capabilities.
- Support appeals of arbitrary BOS reductions through quantitative statements of workload (mission support) capability reductions.

3.1.1 The Prototype Model

The original prototype model, developed in early 1979, made use of the aggregate workload indicators identified during previous research performed by GRC. Aggregate workload indicators are meant to be representative of the kinds of work performed in a particular functional category. They provide an example of the types of impacts that would be produced by changing manpower given the manpower productivity reflected in data used for their development. They do not describe all of the work performed by a BOS functional category nor do they describe how command and base managers might alter BOS manpower production functions so as to minimize impact on primary mission activities.

3.1.2 Prototype Model Capabilities

Figure 3.1 lists the equations that comprised the SAC version of the prototype model. In this example the equations are listed in terms of command manpower requirements. Similar sets of equations were developed for ATC and TAC. The actual model worked with total command manpower and workload.

The first seven equations defined the workload capabilities for the seven OSD functional categories. Equations 8 and 9 defined interrelationships between various manpower and workload indicators. Base population, for example, was correlated with both total population supported (base population and dependents) and military population (base population minus civilians) through aggregate command factors. Thus, a change in base population determined changes in all three population-related indicators.

The prototype model performed three basic calculations:

- The workload indicator impact of changing manpower in one function.
- The workload indicator impact of changing BOS manpower in all functions by a specified amount.
- The manpower savings produced by closing a base.

The prototype model had a number of features and characteristics that made it a useful descriptive tool.

- It accounted for the interrelationships among population-related indicators. If a change in administration (ADM) manpower changed base population, other base services (OBS), other personnel support (OPS), and morale, welfare and recreation (MWR) reflected this change.
- It allowed the user to specify manpower changes in terms of either an absolute number of spaces, a percent of functional manpower or a percent of total BOS manpower.

COMMAND
SAC EQUATIONS

$$\begin{aligned} \text{GADM} &= 234 + .05(\text{G71}) + .0084(\text{G72}) & (1) \\ \text{GRSO} &= 1537 + .00156(\text{G73}) + .0020(\text{G74}) & (2) \\ \text{GMIE} &= -394 + .152(\text{G39}) + .014(\text{G40}) & (3) \\ \text{GOBS} &= 2965 + .0143(\text{G17}) & (4) \\ \text{GMWR} &= 600 + .0033(\text{G12}) & (5) \\ \text{GOPS} &= 748 + .0016(\text{G17}) + .0023(\text{G42}) + 72.4(\text{G44}) & (6) \\ \text{GBHO} &= 298 + .022(\text{G81}) & (7) \\ \text{G7i} &= \text{G17}/2.69 & (8) \\ \text{G71} &= \text{G12}/.842 & (9) \end{aligned}$$

where:

GADM is Administration manpower	G73 is supply transactions
GRSO is Retail Supply manpower	G74 is inventory item records
GMIE is Maintenance of Installation Equipment manpower	G39 is total vehicle inventory
GOBS is Other Base Services manpower	G40 is mileage
GMWR is Morale, Welfare, and Recreation manpower	G17 is population supported including dependents
GOPS is Other Personnel Services manpower	G12 is military population
GBHO is Bachelor Housing manpower	G42 is rations served
G71 is base population	G44 is the number of missile bases
G72 is travel transactions	G81 is visiting officer quarters

Figure 3.1. GEBOS Equations for SAC Prototype Model

- It allowed the user to initiate changes to an individual function or to spread changes across all functions by equal proportions.
- It allowed the user to accumulate manpower changes or return to the FY77 end strength baseline after each model iteration.
- It automatically computed the manpower savings for a base closure from the equation intercepts.

3.1.3 Prototype Model Limitations

The options and methodologies used in the prototype GEBOS as described had a number of limitations.

- The prototype model was driven only by manpower. It lacked a suitable basis for distributing (by functional category) manpower changes associated with a given workload change.
- Only two options were available to change manpower. The user could change total manpower or manpower in one function. If the user desired to change more than one function, he/she was required to perform several iterations of the model. This made it difficult to evaluate changes in terms of the original baseline since the model computed changes from a new baseline after each iteration.
- The model did not produce an answer that was always consistent across all functions when all functions were changed by equal proportions. This was because only one equation was used to determine base population. There was likely to be more manpower than necessary in several functions, because their manpower exceeded what was required for the new base population figure.
- Similarly, it was probably not a realistic option to reach a total reduction by changing all functions by the same percentage. Functions are operating at different relative efficiencies. Some may produce relatively more for an increase in manpower, while others may be less sensitive to reductions.

- Descriptive capability was limited to only seven non-population primary workload indicators.
- Base closures (or openings) could not be treated in combination with other potential changes.
- The prototype model only took into account the interrelationships between population variables. Interrelationships also exist between other workload indicators.

3.1.4 Workload Interrelationships

The GEBOS workload equations are derived through multivariate regression analysis. The workload measures in the prototype model were selected on criteria of explanatory power. The combination of indicators used in the prototype model provided the best estimate of what functional manpower requirements should be.

The multiple regression equations in the prototype GEBOS model had limitations that required resolution before they could be used effectively for a command explanatory model. The workload measures in particular equations were assumed to be independent of one another. An increase in one workload indicator left the other indicator unaffected. Stepwise regression analysis selects workload indicators based on their independent explanatory capability. If a variable is highly correlated with a workload indicator already present in the equation, it would not be added to the model, since it would not improve the estimate of functional manpower requirements.

Despite statistical results, BOS workload indicators cannot be assumed to be independent of one another in the "real world." Relationships do exist between workload indicators and must be taken into account before GEBOS can illustrate workload impacts properly.

An example of the interrelationships can be seen in the OPS functional category. If the number of missile bases is assumed to be constant, equation 6 can be rewritten:

$$\text{GOPS} = 1395 + .0010(\text{G17}) + .0020(\text{G42}) \quad (10)$$

The equation permits the model user to select any combination of the two workload measures, provided the total manpower authorization restriction is not exceeded. For FY78, the equation would allow up to 662,500 rations to be served a month, if no population were supported, or support a total command population, including dependents, of 1,325,000 if no rations were served. However, neither of these alternatives is rational.

Clearly, total independence of workload factors is unrealistic. As population changes, so must the number of rations served for some part of the total population supported will contribute to the rations served workload. Additional relationships between workload indicators were, therefore, required for the model.

One way to modify the model is to explicitly analyze workload indicators that are hypothesized as being related and include the additional relationships between rations served (G42), total population supported (G17), and base population (G71):

$$\text{G42} = 308,055 + 1.128(\text{G71}) \quad (11)$$

$$\text{G17} = 3.14(\text{G71}) \quad (12)$$

Rations served are related to base population. Base population and total population supported are also highly correlated. Therefore, using the substitutions derived from equations 10 through 12, rations served can be related to total population supported:

$$\text{G42} = 308,055 + .3592(\text{G17}) \quad (13)$$

Inclusion of the interrelationships between rations served and total population supported in the current GEBOS model assures that the proportions of workload contributed by rations served and total population supported

agree with the initial proportion. As functional manpower changes the proportion of rations served to total population also changes, as defined by equation 12. Additional bounds can be placed on this proportion, such as restricting it to values greater than .302, the lowest value observed among bases in the SAC data set. These additional restrictions assure that workload factors remain within a feasible operating range.

Some examples of areas where additional workload interrelationships were found include supply workload measures and base population, supply indicators and aviation fuel consumption, vehicle requirements and military population, square feet of dormitory space and military population, and administration transaction data and base population. All potential intercorrelations between workload indicators were investigated, and those found significant are included in the current model. These relationships are described in Appendix E. Existing workload interrelationships for base population, military population, and total population supported remain as part of the model.

3.1.5 Inclusion of Additional Workload Indicators

The prototype model contained a single workload equation for each function. While these equations provided a high degree of explanatory power for estimating manpower authorizations, they were limited in descriptive power. Many additional workload indicators were also highly correlated with manpower authorizations but were excluded from final production function equations because they were highly correlated with indicators already selected for the functional equations and contributed little additional explanatory power. However, including the additional indicators in some way would be useful for describing the different effects of changing manpower requirements.

One way to include additional workload indicators is to derive multiple equations for a function. For example, base population (G71), travel transactions (G72), materiel and services transactions (G55), and BOS budget (G31) were all highly correlated with administration manpower. A set of equations describing manpower from these workload indicators is:

$$\text{GADM} = 1,468 + 0.347(\text{G71}) + .00959(\text{G72}) \quad (14)$$

$$\text{GADM} = 2,515 + .0357(\text{G55}) \quad (15)$$

$$\text{GADM} = -1,640 + 9.85(\text{G31}) \quad (16)$$

$$\text{G72} = -18,389 + .3034(\text{G17}) \quad (17)$$

Administration is now described by three equations and four workload indicators. The additional equation linking travel transactions to a function of total population supported completes the interrelationships among all the administration workload indicators. The same administration manpower has four different workload quantities identified with it.

In developing the current GEBOS model, additional statistical analysis established the appropriate equation forms for a function. These can be found in Appendix D. Combinations of indicators in a single equation are used where such combinations improve the significance of a regression (in terms of R^2 , F statistics), and each workload indicator has a significant individual coefficient (in terms of t-test statistics, F statistics). Meaningful indicators not selected for use in primary production functions are used in an additional set of explanatory equations.

3.1.6 Linear Programming Applications

The current model has the capability to derive the workload impact of a variety of manpower changes. Users may wish to evaluate the impact of total manpower changes or changes to individual functions. The model requires a versatile solution methodology that can solve a large number of interrelationships in a consistent and realistic fashion.

The manpower change capabilities required by the model include:

- The allocation of a change in total BOS manpower among the seven functional categories and calculation of the associated workload change.

- The workload impact of specific manpower changes in all functions, or in selected functions combined with a total BOS manpower change.
- The impact on the manpower and workload in all functions given a manpower change to one or more functions.

Clearly, the problem of distributing general manpower changes among functions and determining interrelated manpower and workload changes requires some technical sophistication. It is not realistic to change all manpower functions or workload indicators by the same proportion. The manpower/workload equations illustrate that different manpower distributions are likely since functions are operating with different levels of variable manpower. Similarly, it is unrealistic to expect all workload indicators to change by the same proportion. This fact was illustrated by the changes to the descriptive indicators for administration in equations 14 through 17. A 10% change in administration manpower produced different changes in base population support capability, BOS budget, travel transactions, and materiel/services transactions.

The approach used for deriving a manpower distribution in the current GEBOS model is to treat the manpower/workload relationships as a linear programming problem. The first task is to determine an objective function for the linear programming model. Since the model in this case will operate from manpower inputs, the objective function must be stated in terms of workload. The user can evaluate workload changes in terms of existing workload performed. If manpower increases, the user would want workload to increase as much as possible. Similarly, for manpower decreases, workload decreases should be as small as possible. Both of these conditions can be met by a workload maximization function.

The objective function of the manpower workload maximization problem takes on the form:

$$\text{Max } Z = \sum_{i=1}^n W_i X_i \quad (18)$$

Thus, the objective of the model is to maximize some combination of the n workload indicators. The manpower feasibility constraints are given by the functional workload equations. Additional constraints are supplied by other workload interrelationships, and restrictions on workload ranges and coefficients.

An example of how this problem is set up is provided by the SAC equations and the additional constraining relationships. The SAC manpower optimization equation system is given in Figure 3.2. The equations in Figure 3.2 describe the most general optimization problem, where total BOS manpower is the binding resource constraint.

Equation 19 is the objective function of the linear programming model. In this case, the objective is to maximize a weighted combination of workload indicators. The workload indicator weights determine the relative importance of different workload capabilities. The derivation of these weights is discussed shortly. There are four types of constraints on manpower and workload. Equations 20 through 26 identify the primary manpower/workload indicator capability constraints. These inequalities determine the minimum manpower requirements for given workload levels. Equations 27 through 36 describe workload interrelationships. These include both equations that relate different workload indicators, such as equations 27 through 35, and minimum value constraints on indicators, such as the support-on-support equation (36). Equation 37 defines the total BOS manpower availability constraint. Implicit in the linear programming routine are non-negativity constraints on manpower and workload values. These conditions assure that all manpower and workload levels remain zero or greater.

The first model input is the workload weights in the objective function. The workload weights serve two purposes:

- Converting different workload units to a common scale.
- Determining the relative importance of different types of workload.

	<u>Sum of Primary Workload Indicators Times Weights (W)</u>	
Maximum Benefit (Workload)	$ \begin{aligned} &W_1(\text{Base Population} + W_2(\text{Total Travel Transactions}) + W_3(\text{Supply Item Records}) + \\ &W_4(\text{Aviation Fuel}) + W_5(\text{Military Vehicles}) + W_6(\text{Total Annual Mileage}) + \\ &W_7(\text{Total Population Supported}) + W_8(\text{Square Feet of Dormitory Space}) + \\ &W_9(\text{Military Population}) + W_{10}(\text{Weighted Rations Served}) \end{aligned} $	(19)
	<u>Production Functions</u>	
	$ \begin{aligned} &-\text{ADM} + .0347(\text{Base Population}) + .00959(\text{Total Travel Transactions}) + S_1 \\ &-\text{RSO} + .00297(\text{Supply Item Record}) + .00936(\text{Aviation Fuel}) + S_2 \\ &-\text{MIE} + .27(\text{Military Vehicles}) + .8614(\text{Total Annual Mileage}) + S_3 \\ &-\text{OBS} + .0121(\text{Total Population Supported}) + S_4 \\ &-\text{BHO} + .0052(\text{Square Feet of Dormitory Space}) + S_5 \\ &-\text{MWR} + .0031(\text{Military Population}) + S_6 \\ &-\text{OPS} + .001(\text{Total Population Supported}) + .002(\text{Weighted Rations Served}) + S_7 \end{aligned} $	Fixed Function Manpower (20) -1,468 (21) -4,419 (22) -164 (23) -2,830 (24) -283 (25) -557 (26) -1,395
	<u>Workload Factor Interrelationships</u>	
	$ \begin{aligned} &3.14(\text{Base Population}) - (\text{Total Population Supported}) \\ &.85(\text{Base Population}) - (\text{Military Population}) \\ &1.128(\text{Base Population}) - (\text{Weighted Rations Served}) \\ &.3034(\text{Total Population Supported}) - (\text{Total Travel Transactions}) \\ &6.329(\text{Base Population}) - (\text{Supply Item Records}) \\ &.0447856(\text{Military Population}) - (\text{Square Feet of Dormitory Space}) \\ &.1193(\text{Military Vehicles}) - (\text{Total Annual Mileage}) \\ &.08948(\text{Supply Item Records}) - (\text{Aviation Fuel}) \\ &.01918(\text{Military Population}) - (\text{Military Vehicles}) \end{aligned} $	Workload Constants (27) 0 (28) 0 (29) -308,055 (30) 18,389 (31) -90,709 (32) -4,395 (33) -324.5 (34) 3,142.3 (35) -2,511.3
	<u>Support-on-Support Relationship</u>	
	$ (\text{Base Population}) - \text{ADM} - \text{MIE} - \text{OBS} - \text{BHO} - \text{MWR} - \text{OPS} + S_8 $	Mission Population (36)
	<u>BOS Manpower Controls</u>	
	$ \text{ADM} + \text{RSO} + \text{MIE} + \text{OBS} + \text{BHO} + \text{MWR} + \text{OPS} $	Total BOS (37)

Figure 3.2. SAC Linear Program Equations

The workload indicators in the objective function were weighted according to the relative manpower cost associated with each unit of output. Thus, the objective function for SAC became:

$$\begin{aligned} \text{Max } Z = & .0347(\text{Base Population}) + .00959(\text{Total} & (38) \\ & \text{Travel Transactions}) + .00297(\text{Supply Item} \\ & \text{Records}) + .00936(\text{Aviation Fuel}) + \\ & .27(\text{Military Vehicles}) + .8614(\text{Total} \\ & \text{Annual Mileage}) + .0131(\text{Total Population} \\ & \text{Supported}) + .0052(\text{Square Feet of Dormitory} \\ & \text{Space}) + .0031(\text{Military Population}) + \\ & .002(\text{Weighted Rations Served}) \end{aligned}$$

This weighting scheme achieved the first purpose of the objective function in that it scales all workload values relative to their manpower costs. Using the marginal manpower coefficients for objective function weights places the same relative value on all workload indicators. Increasing the workload in travel transactions or vehicles maintained by the same percentage would contribute the same amount to the objective function.

The objective function presently used in GEBOS is an artificial construct. The workload interrelationship equations have constrained the optimization process so that a balanced mix of workload change occurs with any increase or decrease in workload capacity. Without workload interrelationships, the optimization function would select the workload indicator with the greatest relative weight and increase it as much as possible, ignoring all other workload indicators. In order to have balanced changes in workload indicators, it is necessary to have at least as many workload interrelationship constraints as the number of workload indicators minus one. The equality relationships between workload indicators assures that the FY78 workload mix will be reproduced for any specification of the FY78 manpower.

In future developmental work, some equalities can be replaced by series of inequalities that allow workload indicator mixes to vary over specified ranges; this will permit the objective functions, which can be weighted to reflect user priorities for various workload types, to influence the distribution of changes.

The objective function presently used in GEBOS does have an economic interpretation. The objective function value Z is proportional to the aggregate "productive" manpower. What is meant by productive manpower is the variable manpower associated with producing workload, rather than fixed manpower requirements or excess functional manpower (slack).

The production functions equations (20 through 26) are stated with the functional manpower values as variables. The specification of functional manpower values as variables permits the simultaneous computation of support-on-support relationships and workload interrelationships. When manpower variables are used, the impact of such interrelationships can be taken into account in the computations.

Equations are stated so that the manpower and workload variables are set equal to the manpower constant term. Slack variables permit the specification of functional manpower greater than required to perform the specified workload levels. Figure 3.3 illustrates the form of the production function equations when manpower values are specified. The functional manpower is added to the constant term in each equation, with the result that the new constant in each equation is the variable manpower. The total BOS manpower control equation is not used when all functions have been specified.

The slack variables S_1 through S_7 are likely to be non-zero for specific distributions. When a manpower distribution is not specified, the optimization procedure eliminates the slack manpower. With a specific manpower distribution, slack manpower will be minimized, but non-zero values will occur if the manpower mix specified differs at all from the optimal distribution.

- .0347(Base Population) + .00959(Total Travel Transactions) + $S_1 = 5,581$ (39)
- .00297(Supply Item Records) + .00936(Aviation Fuel) + $S_2 = 3,481$ (40)
- .27(Military Vehicles) + .8614(Total Annual Mileage) + $S_3 = 2,015$ (41)
- .0121(Total Population Supported) + $S_4 = 4,992$ (42)
- .0052(Square Feet of Dormitory Space) + $S_5 = 49$ (43)
- .0031(Military Population) + $S_6 = 346$ (44)
- .001(Total Population Supported) + .002(Weighted Rations Served) + $S_7 = 1,325$ (45)

Figure 3.3. Production Functions for a Specified Manpower Distribution

The methodology used for specifying a manpower distribution can also be used to specify manpower changes for one to six functions, with a total BOS manpower restriction. For example, an increase of 100 spaces in administration combined with a total BOS increase of 400 spaces would change equations 20 and 37 as follows:

$$.0347(\text{Base Population}) + .00959(\text{Total Travel Transactions}) + S_1 = 5,681 \quad (46)$$

$$\text{RSO} + \text{MIE} + \text{OBS} + \text{MWR} + \text{BHO} + \text{OPS} = 22,156 \quad (47)$$

Equation 46 is exactly the same as in the set for the complete distribution. Equation 47 contains the modified binding constraint on total BOS manpower. Administration manpower no longer is part of the total manpower constraint and the administration variable no longer enters as one of the manpower variables in the constraint.

Other combinations of total manpower and specific functional manpower are handled in a similar fashion. When manpower is specified for a function, that manpower value is no longer computed by the model and the functional value is also removed from total BOS manpower. The model computes the workload for the specified functions, as well as all other functions, and functional slack manpower, if any exists, from the specified partial distribution.

The third manpower option is the computation of the impact of a change in functional manpower in one or more functions with no overall manpower change specified. For example, the user may wish to reduce retail supply operations manpower by 100 spaces. In this procedure, the model computes the manpower and workload reductions in other functions that would be associated with such a reduction in supply.

To perform this computation, changes are made to one equation and the objective function. First, the binding constraint on total manpower is modified by the addition of a slack variable so that it becomes:

$$ADM + RSO + MIE + OBS + MWR + OPS + BHO + S_9 = \begin{matrix} \text{Total BOS} \\ \text{Manpower} \end{matrix}$$

The creation of an artificial slack variable permits the model to use less than the total manpower available to satisfy workload requirements. For the example where supply manpower is reduced, the total manpower constraint becomes:

$$ADM + MIE + OBS + MWR + OPS + BHO + S_9 = \begin{matrix} \text{Total} \\ \text{Manpower} \\ \text{Outside Supply} \end{matrix} \quad (48)$$

One additional change is made to assure the model properly computes the impact of the supply manpower reduction. Since slack functional manpower is counted in the total BOS manpower constraint, any slack manpower created by the supply reduction should be allocated to S_9 , the total manpower slack variable. Otherwise, functional slack manpower would appear as part of the total manpower requirements. The use of S_9 permits the model to use less than the maximum BOS manpower, since S_9 acquires any unneeded manpower created in the other six functions by the reduction to supply manpower. To assure that any nonproductive manpower produced by the supply reduction is taken up by the slack variable, S_9 has a small positive weight placed on it. The objective function becomes:

$$\begin{aligned} Z = & .0347(\text{Base Population}) + .00959(\text{Total Travel} & (49) \\ & \text{Transactions}) + .00297(\text{Supply Item Records}) + \\ & .00936(\text{Aviation Fuel}) + .27(\text{Military Vehicles}) + \\ & .8614(\text{Total Annual Mileage}) + .0131(\text{Total} \\ & \text{Population Supported}) + .0052(\text{Square Feet of} \\ & \text{Dormitory Space}) + .0031(\text{Military Population}) + \\ & .002(\text{Weighted Rations Served}) + .001(S_9) \end{aligned}$$

Placing an arbitrary positive weight, greater than zero but less than the workload weights, assures that any manpower reductions lead to a reduction in total BOS manpower.

The impact of a specific functional increase is computed in the same manner. The only difference is that the total BOS manpower constraint is increased by an arbitrary value larger than any expected manpower increase. The computation procedures are otherwise the same.

3.1.7 Base Opening Costs

An additional manpower option in the current GEBOS model is the computation of the impact of base openings and closings. Base openings and closings change the BOS production function by altering the fixed functional manpower. For example, the addition of a base to SAC will increase the fixed manpower requirement in selected functions.

An estimate of the impact of base opening costs was derived from AFR 173-10, USAF Cost and Planning Factors. Based on the typical base opening package requirements, the base opening costs in the BOS program element by function would be:

- Retail Supply Operations - 165 spaces
- Other Base Services - 193 spaces
- Other Personnel Services - 78 spaces

The base opening package BOS requirements are distributed by organizational unit rather than the OSD functional categories. Therefore, it was not possible to accurately distribute the base opening package by function. Thus, the base opening package manpower was allocated to its three principal functions. A discussion of an alternative distribution scheme is provided in the discussion on validation.

The impact of a base closing is computed by its impact on fixed function manpower. The closing of a SAC base would change the retail supply operations, other base services, and other personnel support functions equations accordingly:

$$\begin{aligned} & -RSO + .00297(\text{Supply Item Records}) + .00936(\text{Aviation} \\ & \text{Fuel}) + S_2 = -4,254 \end{aligned} \quad (50)$$

$$-OBS + .0121(\text{Total Population Supported}) + S_4 = -2,637 \quad (51)$$

$$\begin{aligned} -OPS + .001(\text{Total Population Supported}) + \\ .002(\text{Weighted Rations Served}) + S_7 = -1,317 \end{aligned} \quad (52)$$

By closing a base, the fixed manpower is decreased by the amounts specified. When no change in total manpower is made in equation 37, the total manpower constraint, then the total productive manpower capability is increased by the base opening manpower (i.e., scale economies are realized).

3.1.8 Manipulating Workload

Two options are provided for manipulating workload.

Figure 3.4 illustrates the form of the equations for the workload model. The general form of the equations is the same as in the manpower model, but with three changes.

First, the objective function has been changed to one of minimizing manpower. The workload level is specified, so the objective function has become one of minimizing the manpower needed to perform the required workload.

What was previously the binding constraint on BOS manpower has become the objective function in this form of the model. The new binding constraint in the workload model, equation 70, is now stated in terms of the mission manpower support-on-support equation. Mission manpower is defined as base population minus BOS manpower. This constraint sets the bound on manpower that keeps the objective function from driving the manpower levels to zero.

The production functions have been changed by the removal of slack variables. They are not required for solution of the workload and manpower levels since manpower values are determined directly from workload

<u>Sum of Functional Manpower</u>		
Minimize		
Total BOS =	ADM + RSO + MIE + OBS + MMR + OPS + BNO	(53)
Manpower		
Subject to:		
<u>Production Functions</u>		
-ADM + .0347(Base Population) + .00959(Total Travel Transactions)	Fixed Function Manpower	(54)
-RSO + .00297(Supply Item Records) + .00936(Aviation Fuel)		(55)
-MIE + .27(Military Vehicles) + .8614(Total Annual Mileage)		(56)
-OBS + .0121(Total Population Supported)		(57)
-BNO + .0052(Square Feet of Dormitory Space)		(58)
-MMR + .0031(Military Population)		(59)
-OPS + .001(Total Population Supported) + .002(Weighted Rations Served)		(60)
<u>Workload Factor Interrelationships</u>		
3.14(Base Population) - (Total Population Supported)	Workload Constants	(61)
.85(Base Population) - (Military Population)		(62)
1.128(Base Population) - (Weighted Rations Served)		(63)
.3034(Total Population Supported) - (Weighted Rations Served)		(64)
6.329(Base Population) - (Supply Item Records)		(65)
.0447856(Military Population) - (Square Feet of Dormitory Space)		(66)
.1193(Military Vehicles) - (Total Annual Mileage)		(67)
.08948(Supply Item Records) - (Aviation Fuel)		(68)
.01918(Military Population) - (Military Vehicles)		(69)
<u>Support-on-Support Relationship</u>		
(Base Population) - ADM - RSO - MIE - OBS - MMR - OPS - BNO	Mission Population	(70)

Figure 3.4. SAC Linear Program Equations for Manipulating Workload

values in the production functions. Therefore, slack variables unnecessarily add to the complexity of the computation.

The workload interrelationship equations remain the same as in the manpower change mode. The model receives as input the mission population that requires BOS support. All other workload levels are derived from the mission population level.

The second workload option relaxes most of the BOS workload interrelationships and allows the user to specify values of mission population, travel transactions, supply transactions, aviation fuel consumption, military vehicles maintained, mileage, and rations served. The workload level for these indicators remains unchanged unless the user specifies a change to these indicators. Base population, military population, total population supported, and dormitory space are computed by the model based upon the mission population input.

Only the workload relationships between base population and total population (equation 61), base population and military population (equation 62), and military population and dormitory space (equation 66) are used in the optimization model. All other workload values are determined by user input.

This option permits the user to change the mix of workload from the distribution computed from the use of all workload interrelationships. This option permits the computation of manpower requirements when the user has knowledge that particular workload interrelationships are no longer valid.

3.2 MODEL OPERATION

The linear programming methodology described in the previous section has been integrated into an interactive computer program that allows Air Staff personnel to instantly determine the impact of manpower reductions, justify quantitatively the need for BOS manpower, and program BOS requirements.

This section:

- Describes the program options available to the user.
- Illustrates several representative examples.
- Discusses potential uses of the model output.

3.2.1 Model Options

Figure 3.5 illustrates in flow chart form the various options available to the user on the GEBOS model.

The user first decides the number of commands to be changed on the particular model run. If more than one command is selected for modification on a particular run, the user can only change total BOS manpower. The total change in BOS manpower is allocated by changing the selected commands by the same percentage.

When the user selects only one command for modification, a wider range of user options is available. First, the user decides whether changes will be made in terms of workload or manpower. When workload is selected for change, the user first makes a change to mission population. If no other workload indicators are changed, the model computes all the workload changes based upon the mission population change. If other workload indicators are to be changed, the user must specify the indicators to be changed and the percent change.

When the user decides to manipulate BOS manpower, the first input is concerned with total BOS manpower. The total BOS manpower change can either be specified as an absolute number of manpower spaces, as a percentage of total BOS manpower, or not specified by the user.

If a total change in BOS manpower is not specified, one or more functional manpower changes must be specified. The user can select from among three methods to make functional manpower changes:

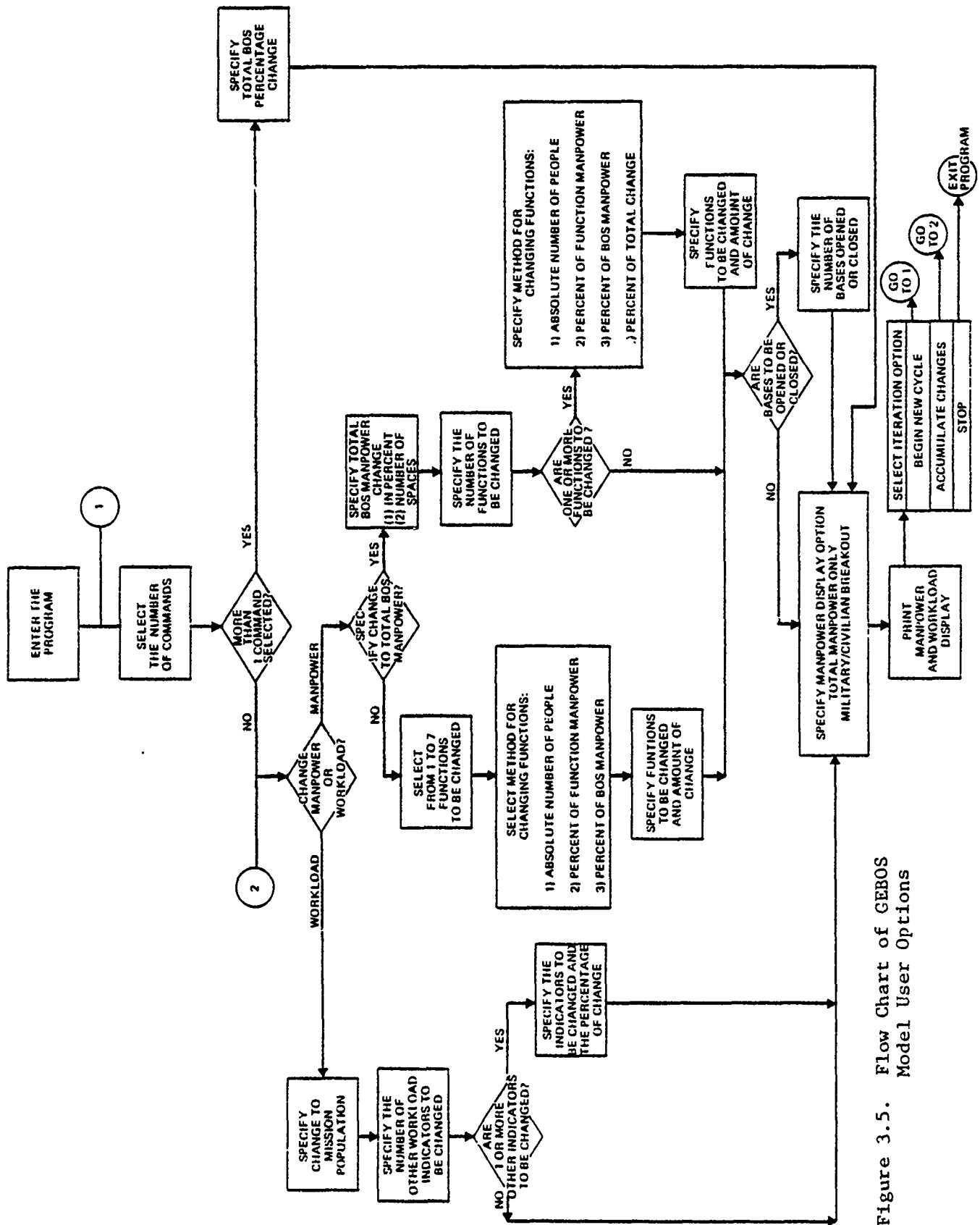


Figure 3.5. Flow Chart of GEOS Model User Options

- The absolute number of people
- Percent of functional manpower
- Percent of BOS manpower

Once the user has determined which method will be used for making changes, the functions to be changed and the amount of change are entered.

When a total change in BOS manpower is specified, the user first enters the change in total BOS manpower, either in terms of percent or total BOS manpower, or total BOS manpower spaces.

Once the user has specified total BOS manpower, the user enters the number of functions to be changed. If the user specifies changes to zero functions, the model computes the functional distribution of manpower changes. If specific manpower changes are specified for function, the model distributes manpower according to the user's specifications. Functional changes are entered either as absolute numbers of manpower spaces, percent of functional manpower, percent of total BOS manpower, or percent of the total BOS change.

Under the manpower option, once the functional changes have been entered, the user has the option of opening or closing bases. The user enters a positive number of bases for increasing the number of bases and a negative number for closing bases.

After all user inputs have been supplied in the manpower and workload options, the display option is selected. The user can display total BOS manpower only, or display additionally the military/civilian breakout of BOS. The model then prints the manpower and workload display.

After the model display is printed, the user has three options. The user can terminate model computation, return to the start of the model, or accumulate the changes to the model values just created.

3.2.2 Examples of GEBOS Model Runs

The following four sample outputs provide examples of the major GEBOS options.

Figure 3.6 illustrates an example of a specified set of manpower changes. In this case, the user specified a 10% total manpower increase by changing all seven functions by 10%. Thus, all functions shared equally in the manpower increase.

The model displays the results of the 10% change in manpower and workload. The manpower changes are listed first. The FY78 SAC manpower is listed by function in the first column, followed by the manpower change, the new functional manpower totals, and the percent change.

The second table lists the slack manpower by function. The slack manpower values indicate where the model has identified more manpower present in a function than necessary for performing the workload levels. This display indicates that increasing all functions equally is not a particularly effective way to manage resources. Only administration is making full use of the additional spaces, and the 790 spaces in retail supply operations were 402 more than were needed. In total, 33.3% of the 2,890.5 space increase was allocated suboptimally.

The output/workload display illustrates how various command capabilities will change, based upon the manpower increase. The indicators are grouped according to six major categories, and FY78 workload levels, the workload change, the new resultant workload capability, and percentage change are listed.

The percentage changes in workload indicators vary considerably. This is due to different sensitivities of change. For example, travel transactions processed was found to be relatively elastic, changing 14.4%, while BOS budget contains a large fixed portion, changing only 6.4%.

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC, 2=SAC, 3=TAC):

2

ENTER CHANGE OPTION (1=MANPOWER, 2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE, 2=PERCENT, 3=NO OVERALL CHANGE SPEC.):

2

ENTER PERCENT CHANGE:

10

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

7

ENTER METHOD BY WHICH FUNCTION CHANGES WILL BE SPECIFIED AS FOLLOWS:

- 1=ABSOLUTE NUMBER OF PEOPLE
- 2=PERCENT OF FUNCTION MANPOWER
- 3=PERCENT OF BOS MANPOWER
- 4=PERCENT OF TOTAL CHANGE

METHOD:

2

ENTER FUNCTIONS AND ASSOCIATED CHANGES (ONE FUNCTION PER LINE)
USING THE FOLLOWING NUMBERS TO DENOTE FUNCTIONS:

- 1=ADMINISTRATION
- 2=RETAIL SUPPLY OPERATIONS
- 3=MAINTENANCE OF INSTALLATION EQUIPMENT
- 4=OTHER BASE SERVICES
- 5=MORALE WELFARE & RECREATION
- 6=OTHER PERSONNEL SUPPORT
- 7=BACHELOR HOUSING OPERATIONS

FUNCTION-CHANGE:

1.10

FUNCTION-CHANGE:

2.10

FUNCTION-CHANGE:

3.10

FUNCTION-CHANGE:

4.10

FUNCTION-CHANGE:

5.10

FUNCTION-CHANGE:

6.10

FUNCTION-CHANGE:

7.10

Figure 3.6. Example of a 10% Increase to All Functions for SAC

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?
 2

ENTER PRINT OPTION AS FOLLOWS:
 1=DISPLAY MILITARY/CIVILIAN BREAKOUT
 2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:
 2

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7047.4	704.7	7752.1	10.00
RETAIL SUPPLY OPERATIONS	7898.6	789.9	8688.4	10.00
MAINTENANCE OF INSTALLATION EQUIPMENT	2179.0	217.9	2396.9	10.00
OTHER BASE SERVICES	7818.7	781.9	8600.5	10.00
MORALE WELFARE & RECREATION	903.0	90.3	993.3	10.00
OTHER PERSONNEL SUPPORT	2719.6	272.0	2991.6	10.00
BACHELOR HOUSING OPERATIONS	338.8	33.9	372.7	10.00
TOTAL	28905.0	2890.5	31795.5	10.00

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	401.96
MAINTENANCE OF INSTALLATION EQUIPMENT	121.58
OTHER BASE SERVICES	171.05
MORALE WELFARE & RECREATION	34.69
OTHER PERSONNEL SUPPORT	47.94
BACHELOR HOUSING OPERATIONS	135.21

Figure 3.6 (Continued)

OUTPUT/WORKLOAD				
WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	106698.6	15315.9	122014.5	14.4
BOS BUDGET	882.0	58.6	938.6	6.4
TRANSACTIONS AUDITED	610585.9	61200.5	671886.4	10.0
LEAVE AND PAY ACCOUNTS	130513.5	15980.2	146493.3	12.2
CIVILIAN PAY RECORDS	21532.4	2636.6	24170.0	12.2
MATERIAL & SERVICES TRANSACTIONS	17937.7	2266.8	20104.5	12.7
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	412286.2	50480.8	462767.0	12.2
BASE POPULATION	131301.3	16076.7	147378.0	12.2
BOS POPULATION	28905.0	2890.5	31795.5	10.0
MILITARY POPULATION	111506.1	13665.2	125271.3	12.2
STUDENTS	0.	0.	0.	0.
MISCION POPULATION	102396.3	13186.2	115582.5	12.9
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2841968.0	344575.1	3186543.1	12.1
SUPPLY TRANSACTIONS	2317056.5	280932.1	2597988.6	12.1
REQUISITIONS	141245.8	17125.4	158371.2	12.1
EQUIPMENT TRANSACTIONS	254924.5	30908.4	285832.9	12.1
RECEIPTS	128741.2	15609.3	144350.4	12.1
TOTAL INVENTORY ITEM RECORDS	1084507.3	119700.9	1204208.3	11.0
SUPPLY ITEM RECORDS	921729.9	101734.6	1023464.5	11.0
EQUIPMENT ITEM RECORDS	162777.5	17966.3	180743.8	11.0
AVIATION FUEL CONSUMPTION	79276.9	9160.4	88437.3	11.6
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL MILEAGE	379.9	30.8	410.7	3.5
TOTAL VEHICLE EQUIVALENTS	33197.9	1842.4	35040.3	5.5
TOTAL VEHICLES	14600.0	810.3	15410.3	5.5
MILITARY VEHICLES	4655.6	258.4	4914.0	5.5
AIRCRAFT TACTOPS	320.8	17.8	338.6	5.5
SPECIAL HANDLING	4334.9	240.6	4575.4	5.5
NON-MILITARY VEHICLES	9944.4	551.3	10496.3	5.5
GENERAL PURPOSE AUTO	1220.7	67.7	1288.5	5.5
ALL PURPOSE TRUCKS	8723.7	484.1	9207.9	5.5
BACHELOR HOUSING INDICATORS:				
10 FT DORM SPACE	9395.0	612.2	10007.2	6.5
DORM BEDS	48272.5	4696.2	53168.7	10.1
OTHER PERSONNEL SUPPORT:				
WEIGHTED PATIENTS SERVED	456162.9	18134.5	474297.4	4.0

ENTER ITERATION OPTION AS FOLLOWS:
 1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP
 ITERATION OPTION=
 3

Figure 3.6 (Continued)

Figure 3.7 illustrates the model's calculations for a 10% manpower increase and one base opening. The base opening is entered by responding yes to the base opening option and entering a "+1," indicating one base is to be opened.

The display in Figure 3.7 indicates a different manpower distribution from the previous example. More manpower has been allocated to administration and other base services, while retail supply operations, maintenance of installation equipment, and morale, welfare and recreation received smaller changes. Slack manpower is zero for all functions in this example since the model was able to allocate all manpower in a productive fashion.

The workload display in Figure 3.7 shows a larger increase in all workload indicators, compared to Figure 3.6. A representative key workload indicator is mission population. In this example, mission population support capability increased by 16.3%, compared to 12.9% in the previous example.

Figure 3.8 illustrates a sample output of the workload change option. In this case, the user made an increase of 21,179 mission population spaces and changed no other workload indicators. This entry produced a 10% increase in total manpower.

The manpower changes are similar to those in Figure 3.7, with administration increasing the most. The workload increases are considerably greater, however, than with the base opening. Mission population supported increased by 20.7%, compared to 16.3% when a base opening occurred.

Figure 3.9 illustrates an example of the workload option where all primary workload indicators are changed for TAC. In addition to mission population, these included travel transactions, total supply transactions, equipment transactions, aircraft tractors, dormitory space, and weighted rations served. The values used corresponded to the actual FY77-FY78

.....

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

.....

ENTER COMMANDS (1=ATC, 2=ZAC, 3=TAC):

2

ENTER CHANGE OPTION (1=MANPOWER, 2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE, 2=PERCENT, 3=NO OVERALL CHANGE SPEC.):

2

ENTER PERCENT CHANGE:

10

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

0

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES, 2=NO)?

1

ENTER NUMBER OF BASES TO BE OPENED(++) OR CLOSED(--):

++1

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7047.4	860.0	7907.4	12.20
RETAIL SUPPLY OPERATIONS	7898.6	673.2	8571.8	8.52
MAINTENANCE OF INSTALLATION EQUIPMENT	2179.0	117.8	2296.8	5.41
OTHER BASE SERVICES	7918.7	913.4	8832.0	11.66
MORALE WELFARE & RECREATION	903.0	51.7	954.7	5.72
OTHER PERSONNEL SUPPORT	2719.6	273.9	2993.5	10.07
BACHELOR HOUSING OPERATIONS	338.8	.5	339.3	.15
TOTAL	38905.0	3890.5	42795.5	10.00

Figure 3.7. Example of a 10% Manpower Increase with a Base Opening

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/MOPKLOAD

MOPKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	106698.6	18669.8	125368.4	17.5
BOS BUDGET	882.0	69.1	951.0	7.8
TRANSACTIONS AUDITED	610585.9	74804.2	685390.1	12.3
LEAVE AND PAY ACCOUNTS	130513.5	19500.5	150014.0	14.9
CIVILIAN PAY RECORDS	21533.4	3217.4	24750.8	14.9
MATERIAL & SERVICES TRANSACTIONS	17837.7	2766.2	20603.9	15.5
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED INCL DEP	412286.2	61601.2	473887.3	14.9
BASE POPULATION	131301.3	19618.2	150919.5	14.9
BOS POPULATION	28905.0	2890.5	31795.5	10.0
MILITARY POPULATION	111806.1	16675.5	128481.6	14.9
STUDENTS	0.	0.	0.	0.
MISSION POPULATION	102396.3	16727.7	119124.0	16.3
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2841966.0	420491.7	3262457.7	14.8
SUPPLY TRANSACTIONS	2317056.5	342826.8	2659883.4	14.3
REQUISITIONS	141245.8	20898.4	162144.2	14.8
EQUIPMENT TRANSACTIONS	254924.5	37718.1	292642.6	14.8
RECEIPTS	128741.2	19048.3	147789.4	14.8
TOTAL INVENTORY ITEM RECORDS	1084507.3	146073.4	1230580.7	13.5
SUPPLY ITEM RECORDS	921729.9	124148.7	1045878.6	13.5
EQUIPMENT ITEM RECORDS	162777.5	21924.7	184702.2	13.5
AVIATION FUEL CONSUMPTION	79278.9	11166.0	90444.9	14.1

Figure 3.7 (Continued)

MAINT OF INSTA EQUIP INDICATORS:				
TOTAL MILEAGE	879.9	37.7	917.6	4.3
TOTAL VEHICLE EQUIVALENTS	33197.9	2254.1	35452.0	6.8
TOTAL VEHICLES	14600.0	391.3	15591.4	6.8
MILITARY VEHICLES	4655.6	316.1	4971.7	6.8
AIRCRAFT TRACTORS	320.8	21.8	342.6	6.8
SPECIAL HANDLING	4334.9	294.3	4629.2	6.8
NON-MILITARY VEHICLES	9944.4	675.2	10619.6	6.8
GENERAL PURPOSE AUTO	1220.7	82.9	1303.6	6.8
ALL PURPOSE TRUCKS	8723.7	592.3	9316.0	6.8
BACHELOR HOUSING INDICATORS:				
30 FT DORM SPACE	9395.0	747.1	10142.0	3.0
DORM BEDS	48272.5	5974.8	54247.3	12.4
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	456162.9	22129.3	478292.2	4.9

THE CHANGE ACHIEVED BY OPENING 1 BASE(S) IS 436

ENTER ITERATION OPTION AS FOLLOWS:
 1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP
 ITERATION OPTION=
 3

.....

Figure 3.7 (Continued)

.....

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

.....

ENTER COMMANDS (1=ATC, 2=SAC, 3=TAC):

2

ENTER CHANGE OPTION (1=MANPOWER, 2=WORKLOAD):

2

ENTER CHANGE IN MISSION POPULATION (OR ZERO TO RETAIN CURRENT VALUE):

21179.2

ENTER THE NUMBER OF WORKLOAD INDICATORS FOR WHICH CHANGES WILL BE SPECIFIED:

0

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7047.4	1055.1	8102.5	14.97
RETAIL SUPPLY OPERATIONS	7398.6	580.5	8479.1	7.35
MAINTENANCE OF INSTALLATION EQUIPMENT	2179.0	144.9	2323.9	6.65
OTHER BASE SERVICES	7818.7	914.5	8733.2	11.70
MORALE WELFARE & RECREATION	903.0	63.4	966.4	7.02
OTHER PERSONNEL SUPPORT	2719.6	129.9	2849.5	4.78
BACHELOR HOUSING OPERATIONS	338.8	2.2	341.0	.64
TOTAL	28905.0	2390.5	31795.5	10.00

Figure 3.8. Example of a Mission Manpower Increase for SAC

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
DETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE INDICATOR	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	106698.6	22920.6	129629.3	21.5
BOS BUDGET	882.0	84.7	966.7	9.6
TRANSACTIONS AUDITED	610585.9	91777.8	702363.7	15.0
LEAVE AND PAY ACCOUNTS	130513.5	23925.3	154438.8	18.3
CIVILIAN PAY RECORDS	21533.4	3947.4	25480.8	18.3
MATERIAL & SERVICES TRANSACTIONS	17837.7	3393.8	21231.5	19.0
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	412266.2	75578.9	487845.0	19.3
BASE POPULATION	131301.3	24069.7	155371.0	18.3
POC POPULATION	28905.0	2890.5	31795.5	10.0
MILITARY POPULATION	111606.1	20459.3	132065.4	18.3
STUDENTS	0.	0.	0.	0.
MISSION POPULATION	102396.3	21179.2	123575.5	20.7
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2841968.0	515915.7	3357883.7	18.2
SUPPLY TRANSACTIONS	2317056.5	420626.0	2737682.6	18.2
REQUISITIONS	141245.6	25641.0	166886.6	18.2
EQUIPMENT TRANSACTIONS	254924.5	46277.6	301202.2	18.2
RECEIPTS	128741.2	23371.0	152112.1	18.2
TOTAL INVENTORY ITEM RECORDS	1084507.3	179222.4	1263729.6	16.5
SUPPLY ITEM RECORDS	921729.9	152322.3	1074052.2	16.5
EQUIPMENT ITEM RECORDS	162777.5	26900.1	189677.6	16.5
AVIATION FUEL CONSUMPTION	79276.9	13687.0	92963.9	17.1

Figure 3.8 (Continued)

MAINT OF INSTA EQUIP INDICATORS:				
TOTAL MILEAGE	879.9	48.4	928.3	5.3
TOTAL VEHICLE EQUIVALENTS	33197.9	2771.6	35969.5	8.3
TOTAL VEHICLES	14600.0	1218.9	15818.0	8.3
MILITARY VEHICLES	4655.6	388.7	5044.3	8.3
AIRCRAFT TRACTORS	320.8	26.8	347.6	8.3
SPECIAL HANDLING	4334.9	361.9	4696.8	8.3
NON-MILITARY VEHICLES	9944.4	830.2	10774.7	8.3
GENERAL PURPOSE AUTO	1220.7	101.9	1322.6	8.3
ALL PURPOSE TRUCKS	8723.7	728.3	9452.0	8.3
BACHELOR HOUSING INDICATORS:				
SQ FT DORM SPACE	9395.0	916.6	10311.5	9.8
DORM BEDS	48272.5	7330.6	55603.0	15.2
OTHER PERSONNEL SUPPORT:				
WEIGHTED PATIENTS SERVED	456162.9	27150.6	483313.5	6.0

Figure 3.8 (Continued)

```

30SPG
*****
      AIR FORCE BASE OPERATING SUPPORT
      AGGREGATE WORKLOAD INDICATOR MODEL
*****

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):
5

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):
2

ENTER CHANGE IN MISSION POPULATION (OR ZERO TO RETAIN CURRENT VALUE):
-5868

ENTER THE NUMBER OF WORKLOAD INDICATORS FOR WHICH CHANGES WILL BE SPECIFIED:
5

ENTER WORKLOAD INDICATOR AND ASSOCIATED PERCENT CHANGES (ONE INDICATOR
PER LINE) USING THE FOLLOWING NUMBERS TO DENOTE WORKLOAD INDICATORS:
1=TRAVEL TRANSACTIONS
2=TOTAL TRANSACTIONS
3=EQUIPMENT TRANSACTIONS
4=AIRCRAFT TACTOPS
5=SQ FT BORN SPACE
6=WEIGHTED PATIONS SERVED

WORKLOAD INDICATOR,CHANGE:
1,4.69
WORKLOAD INDICATOR,CHANGE:
2,-13.55
WORKLOAD INDICATOR,CHANGE:
3,14.39
WORKLOAD INDICATOR,CHANGE:
4,0
WORKLOAD INDICATOR,CHANGE:
5,7.15
WORKLOAD INDICATOR,CHANGE:
6,-11.3-

ENTER PRINT OPTION AS FOLLOWS:
1=DISPLAY MILITARY/CIVILIAN BREAKOUT
2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:
2

```

Figure 3.9. Example of a Change to All TAC Workload Indicators

TACTICAL AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	5180.0	-217.8	4962.2	-4.20
RETAIL SUPPLY OPERATIONS	5208.0	-489.2	4718.8	-9.39
MAINTENANCE OF INSTALLATION EQUIPMENT	1236.0	19.0	1255.0	1.54
OTHER BASE SERVICES	4427.0	-115.0	4312.0	-2.60
MORALE WELFARE & RECREATION	626.0	-9.4	616.6	-1.50
OTHER PERSONNEL SUPPORT	1875.0	-124.4	1750.6	-6.63
BACHELOR HOUSING OPERATIONS	339.0	14.7	353.7	4.33
TOTAL	18791.0	-922.0	17869.0	-4.91

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT WORK LOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	84562.0	3966.0	88528.0	4.7
BOB BUDGET	569.9	-32.2	537.7	-5.6
TRANSACTIONS AUDITED	425233.1	-14517.9	410715.2	-3.4
LEAVE AND PAY ACCOUNTS	99646.8	-6901.4	92745.4	-6.9
COMILIAN PAY RECORDS	14978.4	-1037.4	13941.0	-6.9
MATERIAL C SERVICES TRANSACTIONS	37098.4	-4982.5	32115.9	-13.7

Figure 3.9 (Continued)

POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	368987.0	-25555.5	343431.5	-6.9
BASE POPULATION	98039.0	-6750.1	91248.9	-6.9
SOS POPULATION	18791.0	-922.0	17869.0	-4.9
MILITARY POPULATION	34645.0	-5862.4	28782.6	-16.9
MISSION POPULATION	79248.0	-5868.0	73380.0	-7.4
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2888476.0	-391388.5	2497087.5	-13.5
SUPPLY TRANSACTIONS	2396100.0	-380008.0	2016092.0	-15.9
REQUISITIONS	152659.0	-24210.9	128448.1	-15.9
EQUIPMENT TRANSACTIONS	220525.0	31733.5	252258.5	14.4
RECEIPTS	119192.0	-18903.2	100288.8	-15.9
TOTAL INVENTORY ITEM RECORDS	929105.0	-122303.9	806801.1	-13.2
SUPPLY ITEM RECORDS	812221.0	-106917.7	705303.3	-13.2
EQUIPMENT ITEM RECORDS	116884.0	-15386.2	101497.8	-13.2
AVIATION FUEL CONSUMPTION	45291.0	-15288.0	30003.0	-33.8
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	11347.0	0.	11347.0	0.
MILITARY VEHICLES	4482.0	0.	4482.0	0.
AIRCRAFT TRACTORS	404.0	0.	404.0	0.
SPECIAL HANDLING	4078.0	0.	4078.0	0.
NON-MILITARY VEHICLES	6865.0	0.	6865.0	0.
GENERAL PURPOSE AUTO	736.0	0.	736.0	0.
ALL PURPOSE TRUCKS	6129.0	0.	6129.0	0.
BACHELOR HOUSING INDICATORS:				
SQ FT DORM SPACE	6881.0	492.0	7373.0	7.1
DORM BEDS	32138.0	2337.0	34475.0	7.1
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	344877.0	-39109.1	305768.0	-11.3
ENTER ITERATION OPTION AS FOLLOWS:				
1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP				
ITERATION OPTION=				
3				
STOP RUN COMPLETE				
CAL'S: 5.6				

Figure 3.9 (Continued)

workload changes used in the validation exercises and described in detail in Appendix H.

In Figure 3.9 the workload indicator changes show a mixture of increases and decreases, depending on the values specified. Travel transactions and equipment transactions increased, while mission population and supply transactions decreased. Since the major indicators declined, there was a net decrease in BOS manpower.

3.2.3 Potential Applications

The flexibility of the GEBOS model design will enable it to be used for a variety of manpower planning tasks once its results have been validated. The following examples illustrate some of the principal immediate uses of the model.

Determining the Impact of Manpower Reductions

One of the immediate uses of the model could be to determine how to allocate manpower reductions by functions, and what the workload impact could be. Table 3.1 illustrates how the model would allocate a 10% total BOS reduction by function.

TABLE 3.1
MANPOWER REDUCTIONS BY FUNCTION
(Based on a 10% Total BOS Reduction)

Function	ATC	SAC	TAC
Administration	10.2%	15.0%	16.1%
Retail Supply Operations	7.0	7.4	8.3
Maintenance of Installation Equipment	10.7	6.7	5.9
Other Base Services	10.4	11.7	6.9
Morale, Welfare and Recreation	7.7	7.0	4.0
Other Personnel Support	13.0	4.8	9.7
Bachelor Housing Operations	8.4	0.6	12.3
Total	10.0	10.0	10.0

Both SAC and TAC would reduce administration manpower the most, while reducing retail supply operations and maintenance of installation equipment less than 10%. In ATC, retail supply operations would receive the smallest percentage reduction, while most other major functions would receive reductions on the order of 10%.

Table 3.2 shows the workload impact on six key workload indicators. In all three commands, the mission population supported is highly sensitive to BOS reductions. Other workload indicator changes are more variable, with SAC reducing supply transactions more and total vehicles less than the other two commands.

TABLE 3.2
REDUCTIONS IN KEY WORKLOAD INDICATORS
(Based on a 10% Total BOS Reduction)

Workload Indicator	ATC	SAC	TAC
Mission Population *	14.2%	20.7%	20.5%
Travel Transactions	12.9	21.5	17.1
Supply Transactions	8.3	18.2	11.9
Total Vehicles	11.8	8.3	14.9
Weighted Rations Served	12.0	6.0	10.4
Square Feet of Dormitory Space	13.7	9.8	14.3

* Includes students for ATC.

GEBOs thus produces a variety of useful information for impacting unspecified manpower reductions. First, the best way to take a cut is not to distribute manpower reductions equally to all functions. Administration would receive a larger reduction, and retail supply operations a smaller share. Secondly, any manpower reductions are going to significantly reduce capability to support mission population, given the current production function.

These results can provide manpower planners with additional information on how to allocate manpower reductions within commands. However, validation of all model equations is necessary in order to assure the results are accurate. This includes validation of both the manpower production functions, which determine the workload capabilities of different functions, and the workload interrelationship equations, which determine the changes in the workload mix for different output levels.

Justification of Manpower by Functional Grouping

GEBOS greatly enhances capabilities in terms of describing the manpower requirements for BOS functional groupings. For example, SAC workload can presently be described in terms of 32 different functional workload indicators, rather than in terms of a few specific population variables. Supply manpower includes detailed accounts of the transactions, inventory, and fuel consumption workload impacts that would result from changing functional manpower.

Manpower requirements justification also requires validation before model results can be utilized fully. Such a validation could be accomplished separately through detailed application of Air Force functional manpower standards or as part of a more thorough model validation exercise. The merits of different validation procedures are discussed more fully in the following section.

Manpower Programming

The current model permits aggregate manpower programming through the workload portion of the model. For example, Figure 3.8 shows the BOS requirements and principal workload impacts of a mission manpower change of 21,179 spaces. The model can be used in its current form as a replacement for current BOS manpower programming factors. GEBOS can provide additional detail on manpower requirements by function, and can provide more explanatory power regarding a variety of major workload changes.

Figure 3.9 illustrates how GEBOS can be used for more sophisticated manpower planning exercises. In this case, the manpower planner can

supply the model with additional descriptive information on changes in supplies, equipment, administrative transactional data, and other important indicators on the workload change. When such additional information is available, the model can forecast manpower requirements with greater precision.

The current model form can provide aggregate planning information, but only with several limitations. The manpower production equations and workload interrelationships require validation. This is a necessary step in making the model reliable. But such aggregate planning equations will still lack the required level of detail to be totally effective as a programming tool. In order to accurately program manpower changes, the model will require additional analysis on the workload relationships with primary mission characteristics. Manpower requirements and other workload requirements must be developed so that they relate to primary aircraft authorizations and operational mission requirements. The development of the mission-BOS link is discussed in more detail in Section 4.

3.3 VALIDATION

Four principal approaches were identified for determining model validity:

- Internal verification of computational methodology using existing data.
- Validation through application of historical data.
- Validation through comparison with direct application of standards and guides.
- Validation through comparison with standards/guide application resulting from programmed mission (force structure) changes.

Internal verification of the computational methodology has been completed; given either FY78 manpower authorizations or workload indicators, the model accurately replicates all the workload and manpower data used for derivation of the equations. The internal verification results are given in Appendix H.

The results of the external validation exercises are now discussed.

3.3.1 Historical Validation

Once internal verification had been achieved, the model's predictive capability was tested against FY77 data. This was done through a number of exercises.

- Running FY77 total BOS manpower with the FY78 production functions.
- Running FY77 BOS functional distribution with the FY78 production functions.
- Running FY77 mission population with the FY78 production functions.
- Running FY77 workload indicators with the FY78 production functions.
- Running FY78 total BOS manpower with the FY77 production functions.
- Running FY78 workload indicators with the FY77 production functions.

The detailed discussion of the results of these exercises can be found in Appendix H. The following general results were obtained:

- The FY77 and FY78 production functions allocate manpower in similar fashions. However, neither could accurately predict how changes would occur.
- The FY77 manpower with the FY78 production functions overestimated workload indicators for SAC and TAC and produced mixed results for ATC.
- The FY78 manpower with the FY77 production functions tended to underestimate workload.
- The FY77 workload with the FY78 production functions underestimated manpower for SAC and TAC and overestimated for ATC.

- The FY78 workload in the FY77 production functions overestimated FY78 manpower for SAC and TAC and underestimated manpower for ATC.

In general, historical data proved to be an unreliable validation technique. Substantial changes occurred between the two periods that could not be predicted by the model.

Manpower changed considerably between the two years, most notably for TAC. TAC experienced a total BOS reduction of 15.6%, without undergoing substantial mission changes. Also, the distribution of manpower changes by function, particularly for ATC and TAC, follows patterns that could not be explained by empirical analysis. These results are in agreement with earlier analysis of BOS functional distribution changes that detected no pattern in functional changes from year to year.

Workload changes from year to year also showed considerable variability. Total population supported increased considerably for SAC and TAC, while declining for ATC. Transactional data for supply and accounting and finance showed some large fluctuations as well. Since many indicators have only been collected for two time periods, it is difficult to determine the degree of variability they possess. Mission population indicators, on the other hand, exhibited little variation despite the BOS changes.

The biggest changes between the two years occurred in the production functions. Workload coefficients declined in 22 out of 31 cases between FY77 and FY78. Aggregate manpower productivity increased for TAC and SAC, and declined slightly for ATC. Manpower reductions are the most significant factor in determining productivity changes. For example, TAC experienced a 15.6% manpower reduction, and manpower required to satisfy workload levels declined 19% over FY77. Thus, many workload indicator levels are insensitive to manpower changes.

In general, historical changes cannot be predicted accurately between years. Production function changes, manpower reductions, manpower redistributions, and workload fluctuations occur which cannot be explained by the model. Additional data collection over time will eliminate some spurious variability, but regular update of regression coefficients will be a necessary part of the model maintenance.

3.3.2 Validation Through Standards Application

An exercise was undertaken to explore whether model coefficients are in agreement with results from standards applications and guides. The SAC retail supply operations function was analyzed to determine whether the same workload changes when applied to both the model and the guides would produce the same manpower changes.

The results are described in detail in Appendix I. The aggregate production function and the detailed standards equation are in general agreement on the manpower change. The same workload indicator levels that produce a 10% manpower change in the model will produce a change through the standards of from 11.4% to 12.4%. Also, there are several sources of bias or approximation that once removed are likely to lessen the difference. Thus, in the one case where standards application was undertaken, the GEBOS production function was found to be generally in agreement with standards.

The standards validation exercise has shown:

- The GEBOS production functions can be validated against manpower standards. GEBOS workload indicators can be made compatible with standard equations.
- The process of standards validation would be prohibitively time consuming if done regularly. For retail supply operations alone, there were 50 detailed equations that required estimation. Complete validation would require regular data collection of all detailed standard workload factors, application of both increments and decrements to several bases in

a command, and determination of the detailed manpower changes by military/civilian breakout for proper application of rounding rules.

- Detailed standards application can only validate specific production functions. Standards cannot determine how changes in mission will change the mix of workload. Standards cannot estimate how mission will impact on workload across functions.

3.3.3 Validation Through Programmed Force Structure Changes

The fourth and most reliable validation method is to compare the impact of programmed force structure changes on command manpower files with results from GEBOS when full mission modeling capability is achieved.

The present GEBOS model, when operated in a mission population change mode, can produce the BOS manpower requirements for a change in mission population. These are compared to the current aggregate BOS planning factors in Table 3.3.

TABLE 3.3
COMPARISON OF BOS PROGRAMMING FACTOR

Command	GEBOS	Air Force
	BOS Change as a Percent of Mission Manpower*	BOS Change as a Percent of Primary Program Element Manpower
ATC	12.3	8.0
SAC	13.6	15.0
TAC	12.0	15.0

*Includes real property maintenance, medical, and tenant units.

The GEBOS mission manpower factors are not strictly comparable to Air Force planning factors. GEBOS mission population includes real property maintenance and medical services, which are excluded from the Air Force factors, and uses base population figures which include a variety of tenant units. If adjustments are made for these conditions, the model factors would be much closer to the planning factors.

GEBOS production equation intercepts also produce an estimate of the base opening package. The typical base opening package manpower in the BOS area is 436 spaces. GEBOS production function intercepts total to 234 for ATC, 414 for SAC, and 406 for TAC. When support-on-support is taken into account, these base opening figures become 263 for ATC, 469 for SAC, and 455 for TAC. Considering that base opening factors are beyond the range of observed data for the three commands, the figures compare favorably with the official factors.

These comparisons with planning factors are all in terms of typical or average force changes. In order to completely validate GEBOS and enhance its usefulness as a programming tool, specific force changes must be analyzed. The type of analysis described in Section 4 must be completed for all commands and principal mission capabilities. At that point, the model's results can be tested and calibrated against actual manpower authorization changes.

SECTION 4

BASE OPERATING SUPPORT/MISSION RELATIONSHIPS

This section addresses GRC's exploration of GEBOS model extension to include mission impacts. It describes the need for the additional model developments and outlines the concept and potential benefits to be derived from full mission/BOS capability. A discussion of the analysis of mission relationships, the design of a prototype mission model, and recommendations for further model development follow.

4.1 NEED FOR ANALYSIS OF MISSION RELATIONSHIPS

At present, the GEBOS model has limited capability for use as a predictive model for manpower programming and, in its explanatory (manpower change) mode, can only provide statements of workload indicator change impacts rather than direct mission impacts.

Figure 4.1 is a conceptual display of the GEBOS model BOS/mission extension. BOS manpower requirements are based on peacetime BOS workload. One reason for this is that in wartime the extended work week will increase available manpower by approximately 68%. Also, many BOS workload factors are population- rather than usage-related. For these reasons, there is an implicit assumption that peacetime BOS manpower for a given installation will support its wartime workload (to include deployment commitments). Thus, the key activity in determining the relationship of BOS manpower and mission capability is the analysis of the impact of peacetime mission demands on BOS workload.

Extension of model capabilities to address BOS workload-BOS peacetime mission requirements can make GEBOS a useful programming tool as well as a better explanatory model. Model users can input various mission requirements in terms of aircraft by mission-design-series (M/D/S) and a utilization rate. The M/D/S can then be used to generate various fixed mission manpower and BOS (such as supply inventory requirements) data and the programmed utilization rate, in such terms as flying hours, sorties and/or alert lines, will generate additional activity-related

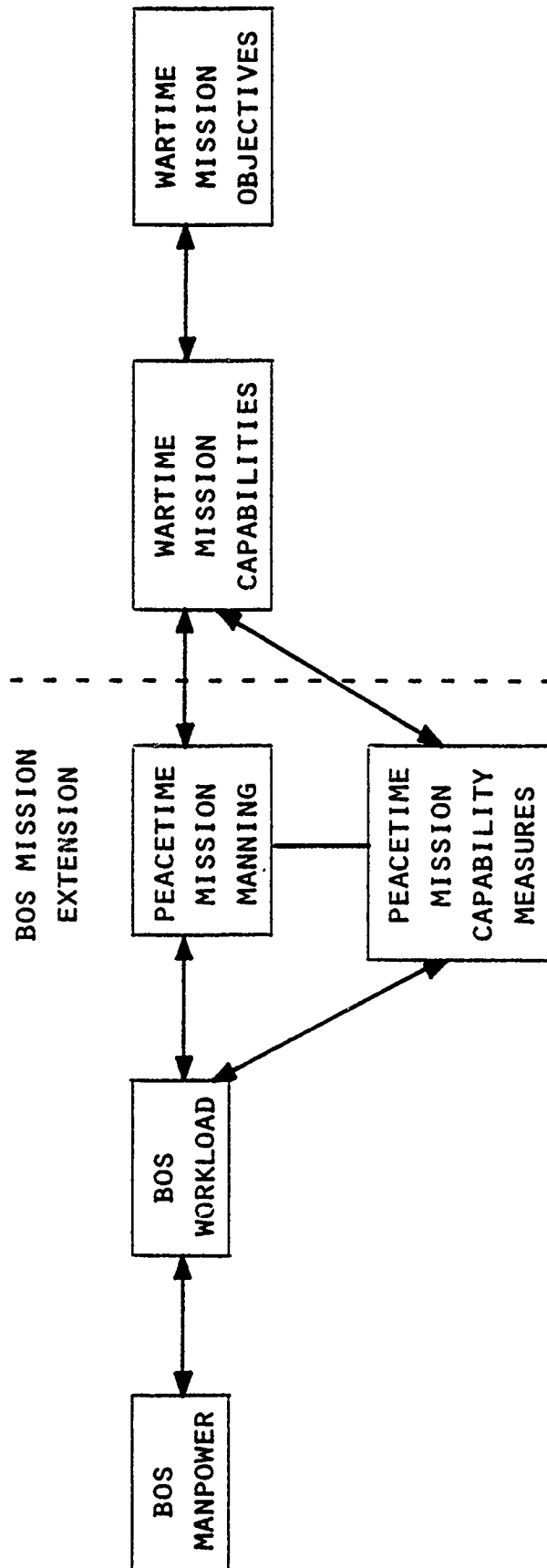


Figure 4.1. BOS-Mission Concept

supply requirements. These total requirements can then determine BOS manpower requirements using production function and constraint relationships similar to those of the existing model.

The final step in determining the impact of BOS changes is the investigation of the relationship between peacetime mission capabilities and wartime mission capabilities and objectives. Flying hours and peacetime sortie requirements are necessary to maintain pilot and crew proficiency. These training requirements relate to ability to perform wartime missions of various types. Wartime mission capabilities will determine what mission objectives the crews can be expected to accomplish. It should then be possible to make quantified statements about the impact of BOS changes on peacetime activity and force levels and the relationship which these changes, in turn, have on wartime capabilities.

The feasibility of extending the GEBOS model to provide a force structure based programming capability was established in a prototype mission (GEBOS-M) model demonstration to Air Staff members. This demonstration, although clearly establishing feasibility, suggests the need for extensive additional research and analysis to fully develop a model capable of fulfilling Air Staff needs. Additionally, further work is required to develop the capability for use of GEBOS-M to display direct mission (combat capabilities/readiness) impacts of BOS reductions.

4.2 DATA COLLECTION AND ANALYSIS

As part of the current research effort, GRC initiated the extension of the GEBOS workload indicator model into mission impacts. The methodology for incorporating mission relationships was developed to take maximum advantage of the existing GEBOS model. Also, the methodology used was designed to consider the ways the Air Force measures its mission.

The first activity with respect to the development of the model was to investigate the Air Force's concepts of mission capability. GRC previously presented to the Air Force a set of potential standards and

measures in the paper "Measures of Mission Capability." A copy of this paper is included in Appendix J. Some of the potential mission capability measures identified are:

- Designed operational capability (DOC) statement
- Training sortie requirements
- Unit capability measurement system (UCMS)
- Force status reports (FORSTAT)
- Operational readiness inspections (ORI)
- Management effectiveness inspections (MEI)
- Operational readiness rates

GRC's development of the BOS-mission relationship proceeded with the investigation of peacetime BOS-mission relationships. This was the logical first step in the BOS extension to mission. As previously mentioned, BOS requirements are determined by peacetime mission requirements. Also, peacetime mission activities would facilitate the empirical investigation of BCS workload.

Primary mission activity data were collected for selected bases in TAC. The base-level data collected included:

- Aircraft inventories by M/D/S
- Flying hours by M/D/S and organization
- Sorties by M/D/S and organization
- Manpower by program element and organization

The data sources are identified in Appendix J.

These mission activity data serve three purposes in the analysis. First, they quantify peacetime mission activity. The quantification of peacetime mission measures permits the development of relationships with GEBOS workload indicators. Also, measurable mission activity data, such as flying hours and sorties, can be associated with mission capability measures such as training sortie requirements.

For the prototype mission model, relationships were identified between the mission activity measures and the workload indicators. Incorporation of factors relating mission activity and workload indicators would permit the computation of the impact of mission change on BOS.

Two preliminary relationships used in the GEBOS-M model are:

- Mission population and aircraft authorizations by M/D/S.
- Flying hours and supply workload indicators.

These preliminary factors supply the initial link between BOS workload and mission activity. Other factors need to be developed for GEBOS-M to achieve a more complete expression of BOS-mission relationships. Additional research into vehicle requirements and a more detailed analysis of supply requirements should be conducted. Also, mission population changes must be analyzed as to their military/civilian proportions and other characteristics that could affect BOS workload requirements. Detailed mission-specific population support factors can replace the aggregate factors used in the prototype GEBOS-M model to more accurately reflect BOS requirements.

A preliminary set of mission-BOS factors was developed for the F-111D in TAC. These factors were:

- A mission population change of 50 spaces per aircraft
- 1306 gallons of aviation fuel per flying hour
- 33.43 supply transactions per flying hour
- 10.45 item records per flying hour

The derivation of these factors is shown in Appendix J. The F-111D factors are preliminary estimates. Supply transactions and inventory are based on command average factors, rather than specific F-111D data. However, they provide reasonable approximations of how mission activity affects base population and supply workload.

4.3 PROTOTYPE MISSION MODEL

The prototype mission (GEBOS-M) model was developed by extension of the GEBOS workload model (addressed in Section 3.1.8) where the user is permitted to vary mission population and other primary capability changes.

The prototype GEBOS-M model works from right to left according to the paths described in Figure 4.1. The prototype model receives as input mission requirements and develops BOS workload constraints from those mission requirements. From this point, the computation is performed in the same fashion as the previous workload model to derive BOS manpower changes and descriptive workload indicators.

Figure 4.2 provides an example of the prototype GEBOS-M model output. After the user selects the mission change option, the following three parameters are supplied:

- Type of aircraft
- Number of aircraft
- Flying hours

Aircraft type 1 represents the F-111D. The user has decided to add 18 F-111Ds with a total of 4320 flying hours (240 hours per aircraft).

Once the mission data changes have been entered, the model computes manpower and workload as described earlier in Section 3.1.8. The output/workload section of Figure 4.2 illustrates how workload indicators would change for this mission change. Various administration indicators such as BOS budget, transactions audited, and leave and pay accounts reflect changes produced by the base population change. Other indicators, such as detailed supply transactions and inventory changes, reflect changes produced by flying hours. Certain areas, such as vehicle indicators, equipment transactions, dormitory space, and rations served, exhibited

 AIR FORCE BASE OPERATING SUPPORT
 AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC, 2=SAC, 3=TAC):
 3

ENTER CHANGE OPTION (1=MANPOWER, 2=WORKLOAD, 3=MISSION CAPABILITY):
 3

ENTER AIRCRAFT M/D/S TYPE, CHANGE IN NUMBER OF AIRCRAFT,
 AND TOTAL FLYING HOUR CHANGE:
 1, 18, 4320

ENTER PRINT OPTION AS FOLLOWS:
 1=DISPLAY MILITARY/CIVILIAN BREAKOUT
 2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:
 2

TACTICAL AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	5180.0	43.8	5223.8	.85
RETAIL SUPPLY OPERATIONS	5208.0	180.5	5388.5	3.47
MAINTENANCE OF INSTALLATION EQUIPMENT	1236.0	-0.0	1236.0	-0.00
OTHER BASE SERVICES	4427.0	19.5	4446.5	.44
MORALE WELFARE & RECREATION	626.0	1.6	627.6	.25
OTHER PERSONNEL SUPPORT	1875.0	6.5	1881.5	.35
BACHELOR HOUSING OPERATIONS	239.0	-0.0	239.0	-0.00
TOTAL	18791.0	251.9	19042.9	1.34

Figure 4.2. Prototype GEBOS-M Example for TAC

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	84562.0	0.	84562.0	0.
BOS BUDGET	569.9	4.5	574.3	.8
TRANSACTIONS AUDITED	425233.1	2918.2	428151.3	.7
LEAVE AND PAY ACCOUNTS	99646.8	1170.8	100817.6	1.2
CIVILIAN PAY RECORDS	14978.4	178.0	15156.4	1.2
MATERIAL & SERVICES TRANSACTIONS	87098.4	1001.5	88099.9	1.1
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	368987.0	4335.5	373322.5	1.2
BASE POPULATION	98039.0	1151.9	99190.9	1.2
BOS POPULATION	18791.0	251.9	19042.9	1.3
MILITARY POPULATION	84645.0	994.5	85639.5	1.2
MISSION POPULATION	79248.0	900.0	80148.0	1.1
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2888476.0	144423.8	3032899.8	5.0
SUPPLY TRANSACTIONS	2396100.0	129707.7	2525807.7	5.4
REQUISITIONS	152659.0	8263.9	159922.9	5.4
EQUIPMENT TRANSACTIONS	220525.0	0.	220525.0	0.
RECEIPTS	119192.0	6452.2	125644.2	5.4
TOTAL INVENTORY ITEM RECORDS	929105.0	45137.4	974242.4	4.9
SUPPLY ITEM RECORDS	812221.0	39459.0	851680.0	4.9
EQUIPMENT ITEM RECORDS	116884.0	5678.4	122562.4	4.9
AVIATION FUEL CONSUMPTION	45291.0	5642.2	50933.2	12.5
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	11347.0	0.	11347.0	0.
MILITARY VEHICLES	4482.0	0.	4482.0	0.
AIRCRAFT TRACTORS	404.0	0.	404.0	0.
SPECIAL HANDLING	4078.0	0.	4078.0	0.
NON-MILITARY VEHICLES	6865.0	0.	6865.0	0.
GENERAL PURPOSE AUTO	736.0	0.	736.0	0.
ALL PURPOSE TRUCKS	6129.0	0.	6129.0	0.

Figure 4.2 (Continued)

BACHELOR HOUSING INDICATORS:				
50 FT DORM SPACE	6881.0	0.	6881.0	0.
DORM BEDS	32138.0	0.	32138.0	0.
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	344877.0	0.	344877.0	0.
MISSION INDICATORS:				
F111D FLYING HOURS	-0	4320.0	4320.0	*****
F111D SORTIES	-0	1763.5	1763.5	*****

Figure 4.2 (Continued)

no changes. Further analysis is required to compute the necessary factors in these areas. One additional feature of the prototype GEBOS-M model is that the workload indicator display has been expanded to portray the change in flying hours and sorties flown by aircraft type.

The prototype model requires little modification to become a useful programming tool. Once other types of aircraft have been analyzed as to their support requirements, manpower planners can use the model to estimate BOS requirements for force structure changes. Rather than relying on aggregate command BOS programming factors, once validated, the model will compute BOS requirements generated by changes in force structure by M/D/S and activity rate.

In addition to providing more accurate manpower programming capability, the prototype GEBOS-M model allows BOS requirements to be stated in terms of mission. An increase in BOS manpower can be identified as being required to support specific types of aircraft and flying hour programs. Furthermore, the mission capability measures themselves can be extended to show their relationship to a specific wartime role. Figure 4.1 also illustrates this concept. Aircraft types and flying hour programs can be connected to designed operational capability statements for wartime readiness and sortie generation capability. The wartime mission capabilities can be related directly to the Air Force's achievement of its wartime mission. Completion of this link will greatly enhance the justification of BOS requirements.

4.4 GEBOS-M CONCEPTUAL APPROACH

GRC has developed the following conceptual framework for the full development of the GEBOS-M model. The concept is based on the current linear programming structure which was developed fully in the current GEBOS model.

The prototype GEBOS-M model illustrates the basic approach on how peacetime mission changes can be related to BOS manpower requirements.

However, to develop the full potential of the mission-BOS concept, research is required in the following areas:

- Further analysis of ways peacetime mission activity impacts BOS workload.
- Development of a methodology for relating BOS reductions to a variety of peacetime mission impacts.
- Exploration of the relationship of peacetime mission requirements to wartime mission capabilities and the ability to achieve wartime mission objectives.

The first goal of analyzing the ways peacetime mission can be related to BOS requirements can be achieved through an extension of the demonstration or prototype GEBOS-M model. The objective function used in the current GEBOS workload model, minimizing manpower requirements necessary for the achievement of various workload levels can be used for this purpose. Additionally, the workload constraints can be altered to reflect peacetime mission capabilities rather than aggregate workload constraints.

An example of this methodology was provided by the prototype GEBOS-M model. Rather than deriving fuel consumption based on aggregate correlations between retail supply operations manpower and aggregate supply transactional data, specific relationships were derived between aircraft by M/D/S and supply requirements. The fuel consumption constraint in the prototype GEBOS-M model became:

$$\text{Aviation Fuel Consumption} = 45,291 + 1.306(\text{F-111D Flying Hours})$$

This constraint can be extended to all aircraft in a command to become:

$$\text{Aviation Fuel Consumption} = b_0 + \sum_{i=1}^n b_i FH_i$$

where

b_0 is the constant

n is the number of M/D/S aircraft types in a command

b_i is the fuel consumption rate for M/D/S type i

FH_i is the number of flying hours for M/D/S type i

Similar relationships can be derived between other BOS workload indicators and mission capability measures. Each M/D/S aircraft will have a variety of factors to describe its mission manpower, fuel consumption, supply transactions, vehicle requirements, and other support requirements in a way that is directly compatible with the design of GEBOS. Similar relationships can be established for missile units.

Extension of the GEBOS-M model so that direct mission impacts can be derived from BOS manpower changes requires additional methodological development. The mission/workload factors required to derive the BOS impact of mission changes are necessary for this phase of model development, but not sufficient by themselves to enable the selection of specific alternative mission capability changes. A generalized GEBOS-M model of BOS impacts on peacetime mission capabilities should include:

- Establishment of a priority structure among different units or M/D/S types to enable the model to determine the order in which mission capabilities should be increased or decreased.
- Analysis of the relative value of different mission activity levels such as sortie rates, flying hours, or readiness factors.
- Determination of the relative support costs of different M/D/S aircraft and activity levels, either in terms of manpower requirements or workload levels.
- Development of alternative model operating modes, such as changing the manpower/workload production functions as a means of achieving manpower objectives.

In a command, there are a number of mission reductions that would yield the same manpower reduction in BOS. For example, TAC could reduce its mission by X number of F-15s or Y number of F-4s and achieve the same support reductions. Any further development of mission capability impacts of BOS reductions requires a weighting structure on the importance of different force structure elements and capabilities. Such a system might be based on Air Force judgments as to relative mission rankings, such as the unit priority system; alternatively, users could modify unit priorities explicitly for specific purposes.

Analysis is also required to determine the relative sensitivity of different levels of mission activity in relation to support reductions. This analysis should take into account explicit wartime capability requirements such as the DOC statements. The impact of reduced flying hours, for example, should be related to the training flight requirements necessary to maintain various degrees of mission capability as defined in the DOC.

The BOS savings resulting from reductions in various mission elements can be derived in a number of ways from existing mission data. Once the relationship of specific mission capability measures has been completed, these mission capabilities can be evaluated using the GEBOS-M model in the mode that estimates BOS changes. The BOS impacts produced from the model would correspond to the types of manpower and workload impacts produced by the prototype GEBOS-M model. The user can employ the manpower or workload values derived from running the model to selectively adjust unit priorities or mission capabilities as necessary.

The final development necessary to enable the GEBOS-M model to estimate manpower/workload impacts is for the model operation to include other impact options. For example, Air Force manpower managers might severely limit other support activities rather than reduce flying hours or sorties. Standards of living could be reduced or the workweek extended rather than directing the impact toward primary mission capabilities. These considerations can be taken into account by increasing

available manhours in total BOS, or reducing selected model workload coefficients. A 10% increase in BOS manhours can be encompassed by increasing the total BOS manpower constraint by 10%. Productivity increases can be addressed by allowing workload coefficients in the GEBOS-M production equations to vary over specified ranges or by specified percentages. BOS reductions can be designed to downgrade mission capabilities from fully mission capable to partially mission capable, selectively reduce sortie generation rates and/or sortie length, and decrease reaction time. Derivation of the alternatives for inclusion in GEBOS-M would include analysis of official mobilization plans, survey of Air Force personnel as to relative importance of factors, and/or judgmental user inputs.

Once model capability has been extended so that the BOS changes can be related to peacetime mission capability, the impact of peacetime mission capability on wartime capabilities and objectives can be derived. The peacetime training requirements and capabilities can be related to wartime missions. For example, DOC statements can be used to convert loss of unit capabilities to loss of unit sortie generation, flying hours, and types of mission. These quantified impacts of mission capabilities can be related to wartime objectives under different scenarios.

The specific technical approach that best reflects the variety of requirements for full mission capability will depend on both additional research findings and specific user requirements. One approach would be to enhance the current linear programming technique in GEBOS with additional features. For example, unit priorities could be included by a module that specified the order in which unit capabilities would be decremented. The model would reduce mission capabilities in order of the priorities until various manpower and/or workload objectives are achieved. The user could also modify priorities or objective function weights if desired.

Similarly, the linear programming problem could be modified to include integer programming or goal programming techniques. For example, it is only reasonable to change manpower, M/D/S aircraft, or sorties by integer units. Also, goal programming could provide a technique for incorporating several different mission objectives in the objective function. Rather than maximizing the mission objective function, goal programming would seek to come as close as possible to a set of specified objectives.

The final task of relating peacetime mission capabilities to wartime mission capabilities and objectives could also be accomplished in several ways. Wartime capabilities could be handled either as the objective function of an optimization model, or derived from peacetime mission capabilities. It appears preferable at this time to make the transition from peacetime to wartime as a separate phase apart from the basic model computations. Separation of the extension to wartime capabilities would allow users to separately assess the mission capability reductions as to their reasonableness, and obviate security problems with GEBOS-M development.

SECTION 5
RECOMMENDATIONS

With regard to its research on BOS manpower, workload indicators, and mission elements, GRC has expanded the Air Force's knowledge of BOS relationships. Specific tools and methodologies have been developed that will enable the Air Staff to obtain additional useful products based upon GRC's research effort. There are two areas where additional effort will enable the Air Force to fully utilize the current findings and obtain the maximum benefit made possible by these innovative tools. These recommendations center around extension of GEBOS to the entire Air Force, including model validation, and further development of mission-BOS relationships.

5.1 EXTENSION OF GEBOS AIR FORCE-WIDE

The GEBOS model has been made fully operational for ATC, SAC, and TAC. The reports and analyses that GEBOS is capable of producing document the desirability of continuing with GEBOS by implementing the model Air Force-wide. Based on GRC's research, the data elements, sources, and data reporting requirements for Air Force-wide implementation have been identified.

The following recommendations are made for completion of the model within the framework established by GRC:

- Additional data on GRC-identified descriptive indicators should be collected. AFMEA currently is collecting all aggregate manpower data and many of the workload indicators necessary for Air Force-wide model implementation. However, the data collection effort should be augmented with additional descriptive indicators such as those described in Appendix A.
- Workload indicators, particularly transactional data, should be regularly collected and updated. Regular quarterly or monthly collection of many aggregate indicators will eliminate biases caused by using only 1 month's data for estimating workload.

- Aggregate manpower/workload equations should be developed annually. Manpower/workload relationships can change considerably from year to year as productivity changes.
- Multivariate analysis should be accomplished to establish workload indicator relationships for all commands. Such interrelationships are necessary for the model to accurately portray balanced resource changes. Also, development of interrelationships for all commands will provide an update of (and replace) aggregate BOS planning factors, since the GEBOS model now permits production of BOS requirements as a function of mission population changes.
- Model development should be extended to other functional categories. Collection of manpower and workload data on real property maintenance and medical services should continue. Additional analysis should be performed to develop similar equations for these functional categories.
- The GEBOS model can be made operational either on an Air Force computer or a commercial time sharing system.

Model validation will become an increasingly important requirement once GEBOS has been implemented Air Force-wide. At that point, it will be necessary to compare the model's manpower and workload projections within an independent external source of estimation. Such validation efforts will assure that the results from GEBOS are consistent with other Air Force manpower estimating procedures.

Three principal validation techniques have been identified:

- Historical validation
- Standards validation
- Mission change validation

Historical validation is done by running the model against either manpower or workload data. Historical validation, as discussed in Appendix H, indicates that regular update of model coefficients is necessary

as productivity changes occur from year to year. However, historical validation is not sufficient to satisfactorily verify model coefficients.

The methodology for a standards application was set forth in Appendix I. Basically, workload changes produced by GEBOS are priced out in detail by work center. Total functional manpower changes in the model are then compared to aggregate work center manpower changes. Any model discrepancies can then be investigated and reconciled.

GRC undertook the validation of the retail supply operations functional category for SAC and found the results very encouraging. The model and standards estimates of manpower changes were within an acceptable range, considering the various approximations and assumptions made.

Standards validation can be undertaken upon completion of the Air Force-wide GEBOS model. However, there are some limitations on the usefulness of using standards for extensive Air Force-wide model validation.

First, the amount of data required for complete Air Force-wide validation through standards would be considerable. One command required application of 50 detailed standards to price-out one functional category. Complete application of Air Force standards for all bases would require many more standards involving many additional commands. Considerable additional workload data beyond what are necessary for model development would have to be collected or estimated. Several typical bases should be priced out for each command for both manpower increments and decrements. Such an Air Force-wide standards price-out would require extensive data collection, data processing, and computation.

Another limitation on the applicability of work center standards validation to GEBOS is that the work center standards do not describe mission requirements. In order for GEBOS validation to be complete, a determination must be made of how manpower changes will occur across all functions simultaneously. This is accomplished in GEBOS through workload

interrelationship factors. Standards do not address workload interrelationships. Consequently, standards will provide no guidance as to how much of a workload change would be required for supply indicators relative to administration indicators for any aggregate change in mission capability.

For these reasons, standards are of limited use for complete GEBOS validation. However, standards validation can prove useful to price out selected functional categories. Such selected price outs could be desirable where there is a need to confirm estimates for particular workload coefficients or where additional insights into manpower/workload relationships are desired.

The recommended validation approach is to withhold GEBOS validation until the relationships between mission capabilities and BOS workload indicators have been completed. Once the impact of specific force structure changes can be estimated through GEBOS-M, such impacts can be validated against recent historical force structure changes. Validation of mission relationships would be more efficient in terms of data collection and analysis and would provide more complete validation.

5.2 DEVELOPMENT OF FULL MISSION RELATIONSHIP

GRC demonstrated the prototype design of a GEBOS model that incorporates mission relationships in November 1979. It would be useful to the Air Force to pursue additional research of GEBOS toward three goals:

- Full development of the relationships between mission capabilities and BOS workload.
- Development of a method for establishing mission priorities so that BOS reductions can be allocated across different mission areas.
- Extension of the impact of mission reductions from peacetime to wartime capabilities.

The general research requirements for further analysis in the mission area are outlined in Section 4.4. The development of GEBOS-M to achieve these three goals will provide AF/MPM with a way of accurately programming BOS requirements associated with force mission changes, justification for BOS manpower in terms of mission impacts, and a general tool and methodology for analyzing BOS/mission alternatives.

APPENDIX A
DATA COLLECTION

DATA COLLECTION

The primary source of data for the following analyses was from AFMEA/MEUR. Additionally, 21 other workload indicators were collected by GRC from five additional sources. The FY78 manpower and workload indicators, along with their sources, are listed in Table A.1.

Some of the sources provided data that were the same or similar to data from other sources. For example:

- V09 is identical to V13.
- V22 is the same as V28, except for being from a different month.
- V23 is the same as V29, except for being from a different month.
- V24 is a subset of V30, except it was collected during a different month.

The data requests to AFMEA/MEUR; AFAFC/RM; AFDSC/LGSM; and SAC/LGT, TAC/LGT, and ATC/LGT are provided in Annex 1 to this appendix.

TABLE A.1
MANPOWER AND WORKLOAD VARIABLES^a

Variable		Format	Record	Columns
Name	Variable Label			
V01	Year	F 2.0	1	2-3
V02	Command	F 1.0	1	4-4
V03	Base	F 6.0	1	6-11
V04	ADM-Administration Manpower	F 6.0	1	13-18
V05	Total Base Officers	F 6.0	1	20-25
V06	Total Base Airmen	F 6.0	1	27-32
V07	Total Base Civilians	F 6.0	1	34-39
V08	Total Contracts	F 6.0	1	41-46
V09	Total Travel Transactions	F 6.0	1	48-53
V10	Transactions Audited ^b	F 6.0	1	55-60
V11	Total Air Force Members ^b	F 6.0	1	62-67
V12	Civilian Pay Accounts ^b	F 6.0	1	69-74
V13	Travel Transactions Processed ^b	F 6.0	1	76-81
V14	Commercial Service Transactions Processed ^b	F 6.0	1	83-88
V15	Materiel Account and Finance Workload ^b	F 6.0	1	90-95
V16	BOS Budget ^c	F 6.0	1	97-102
V17	RSO-Retail Supply Operations	F 6.0	1	104-109
V18	Distillates	F 6.0	1	111-116
V19	Residuals	F 6.0	1	118-123
V20	MO-Gas	F 6.0	1	125-130
V21	Aviation Fuel	F 6.0	1	132-137
V22	Supply Transactions	F 6.0	1	139-144
V23	Equipment Transactions	F 6.0	1	146-151
V24	Supply Item Records	F 6.0	1	153-158
V25	Total Requisitions ^d	F 6.0	1	160-165
V26	Total Dollar Value-Thousands ^d	F 6.0	1	167-172
V27	Total Receipts ^d	F 6.0	1	174-179
V28	Total Supply Transactions ^d	F 6.0	1	181-186
V29	Total Equipment Transactions ^d	F 6.0	1	188-193

TABLE A.1 (Continued)

Variable		Format	Record	Columns
Name	Variable Label			
V30	Total Item Records ^d	F 6.0	1	195-200
V31	MIE-Equipment Maintenance	F 6.0	1	202-207
V32	Aircraft Tractors	F 6.0	1	209-214
V33	General Purpose Automobiles	F 6.0	1	216-221
V34	All Purpose Trucks	F 6.0	1	223-228
V35	Special Handling Equipment-Warehouses	F 6.0	1	230-235
V36	Special Handling Equipment-Fire Fighting	F 6.0	1	237-242
V37	Special Handling Equipment-Other	F 6.0	1	244-249
V38	Total Registered Vehicles ^e	F 6.0	1	251-256
V39	Total Registered and Non-Registered Vehicles ^e	F 6.0	1	258-263
V40	Total Vehicle Equivalents ^e	F 6.0	1	265-270
V41	Total Annual Mileage-Millions ^e	F 6.0	1	272-277
V42	OBS-Other Base Services	F 6.0	1	279-284
V43	Total Population Supported ^c	F 6.0	1	286-291
V44	Total Air Traffic Control Operations ^f	F 6.0	1	293-298
V45	BHO-Bachelor Housing Operations	F 6.0	1	300-305
V46	Dorm Beds	F 6.0	1	307-312
V47	Square Feet of Dorm Space	F 6.0	1	314-319
V48	Weighted Rations Served	F 6.0	1	321-326
V49	MWR-Morale, Welfare and Recreation	F 6.0	1	328-333
V50	Student Population ^c	F 6.0	1	335-340
V51	OPS-Other Personnel Services	F 6.0	1	342-347
<u>Computed Variables</u>				
X01	Base Population $X01 = V05 + V06 + V07$			
X02	Base Population with Contract Man-Years $X02 = V05 + V06 + V07 + V08$			
X03	Ground Fuel Consumption $X03 = V18 + V19 + V20$			
X04	Total Vehicles $X04 = V32 + V33 + V34 + V35 + V36 + V37$			

TABLE A.1 (Continued)

<u>Computed Variables (Continued)</u>	
X05	Military Population $X05 = V05 + V06$
X06	Travel Transaction Proportion $X06 = V09/V14$
X07	Total Transactions Processed $X07 = V25 + V27 + V28 + V29$
X08	Average Items per \$1000 Inventory $X08 = V30/V26$
X09	Service Material Transactions $X09 = V14 + V15$
X10	Military Vehicles $X10 = V32 + V35 + V36 + V37$
BASE 1	SAC Missile Bases

INPUT FORMAT FIXED (1X,F2.0,F1.0,49(1X,F6.0))

^aUnless otherwise indicated, these data are from AFMEA BOS Manpower and Workload Data.

^bSource: HAF-ACF(M) 7104, Report of Accounting and Finance, September 1978.

^cSource: DD-MRA&L-M(OT) 7765, Domestic Base Factors Report for FY1978.

^dSource: Special Management Data Bank Inquiry, M-32 Monthly Base Supply Management Report, October 1978.

^eSource: Special Request from HQ SAC/LGT, HQ TAC/LGT, HQ ATC/LGT, as of 30 September 1978.

^f1411-DOT-QU, Annual Air Traffic Control Operations Report, FY78.

ANNEX 1

LETTERS TO AFMEA/MEUR; AFAFC/RM; AFDSC/LGSM; AND
SAC/LGT, TAC/LGT, AND ATC/LGT

20330

13 JUL 1979

MPME /Maj Steadman/19 Jul 79/71025/cm

Creation of FY 78 Data File for BOS Workload Indicators

AFMEA/MEU

1. This correspondence is to confirm conversations on the subject between AF/MPME, AFMEA/MEUR, and General Research Corporation (GRC) personnel. As part of the validation phase of follow-on GRC research on aggregate BOS indicators, request the data be provided for SAC, TAC, and ATC.

2. Format Specifications have been previously provided to you by GRC personnel. To ensure timely progress on the research, the data must be received by this office no later than 27 Jul 79.

3. Questions may be directed to Major Steadman, Autovon 227-1025.

FOR THE CHIEF OF STAFF

WALTER EDWARDS

Deputy Chief, Mgt Engrg & Analysis Div
Dir, Manpower & Orgn, DCS/M&P

Copy to; AF/MPMPC

M/R: AFMEA is expecting and can meet the date.
I will datafax when signed.

M/R:
Datafaxed to Roy S.
on 20 Jul 79
Steadman

Office Symbol	: MPME	: 2	: 3	: 4	: 5
Grade &					
Surname of	LTC Roberts	:	:	:	:
Coordinating	19 Jul 79				
Officers	Maj Steadman	:	:	:	:
	19 Jul 79				

mpme coord cy
mpme stybk cy
mpme read cy

MPME /Maj Steadman/6 Jul 79/slb/71025

Request for Information to Support Research Project

AFAFC/RH

1. This office is responsible for several research and analysis projects, one of which concerns development of a methodology for aggregate BOS output indicators. A key point of the research is the identification of base level aggregate workload indicators.

2. Accordingly, request the following information be provided for FY 78, by individual bases in SAC, TAC, and ATC.

- a. Transactions Audited (1511)
- b. AF Member Serviced for Pay and Leave (1512)
- c. Civilian Pay Accounts Maintained (1513)
- d. Travel Transactions Processed (1514)
- e. Commercial Services Transactions Processed (1515)
- f. Materiel Transactions Processed (1516)

3. Your support is appreciated. Questions may be directed to the project officer, Maj Steadman, Autovon 22, extension 71025, 73396.

FOR THE CHIEF OF STAFF

1. The following information is requested from the bases listed below:

MR. These data are necessary to conduct validation of the GRC GEBOS model developed under an AFOSR contract.

Office Symbol	:1	:2	:3	:4	:5
Grade &					
Surname of					
Coordinating					
Officers					

MPME

Mr. Roberts

9 July 79

10 July 79

✓ MPME COORD
MPME RF
MPME STYBK

Enclosure 2

20330

MPME /Maj Steadman/6 Jul 79/slb/71025

9 JUL 79

Request for Information to Support Research Project

AFDSC/LGSM

1. This office is responsible for several research and analysis projects, one of which concerns development of a methodology for aggregate output indicators for use in Air Staff-level manpower management. A key part of the research is the identification of base level output indicators which can be used in this aggregate process.

2. Since supply support at base level affects all activities and therefore may be a prime source for these indicators, request the following information from the SBSS M-32 report be provided from your data base, on a priority basis, for FY 78 end year totals, by individual CONUS bases in SAC, TAC and ATC.

- a. Total receipts.
- b. Total item records.
- c. Total number of requisitions.

3. Your support is appreciated. Questions should be directed to the project officer, Major Steadman, Autoyon 22, extensions 71025/73396.

FOR THE CHIEF OF STAFF

THOMAS EDWARDS
Deputy Chief, Manpower & Logistics Div
AFDSC/LGSM

MR. These data are necessary to conduct validation of the GRC GEBOS model developed under an AFOSR contract.

Office Symbol	: <u>MPME</u> :	2	:3	:4	:5
Grade &					
Surname of			:		
Coordinating	<i>Mr. Roberts</i>				
Officers	<i>10 Jul 79</i>				

A-11

✓ MPME COORD
MPME RF
MPME STYBK

Enclosure 3

— 100 —

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HQ ATC/LGT

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APPENDIX B

COMPARISON OF FY77 AND FY78 MANPOWER AND WORKLOAD

COMPARISON OF FY77 AND FY78 MANPOWER AND WORKLOAD

MANPOWER ANALYSIS

The current version of GEBOS contains seven DOD functional categories dealing with base operating support (BOS). These are:

- Administration (ADM)
- Retail Supply Operations (RSO)
- Maintenance of Installation Equipment (MIE)
- Other Base Services (OBS)
- Morale, Welfare and Recreation (MWR)
- Other Personnel Support (OPS)
- Bachelor Housing Operations (BHO)

Table B.1 describes the Air Force functional account codes which comprise these seven functional categories.

Table B.2 presents the manpower distributions in each functional category for FY78. The major functions are ADM, RSO, and OBS which together comprise nearly 70% to 80% of the manpower in each of the three commands. OPS and MIE come next, while MWR and BHO contain the fewest individuals.

Table B.3 illustrates the percentage change in manpower for each functional category within the commands from 1977 to 1978. It appears that major changes have taken place from 1977 to 1978, particularly in TAC. Only ATC shows an overall increase in manpower (4.4%), with the largest percentage increases occurring in ADM, MIE, and BHO, although the absolute gains in the latter were not very large. Slight manpower declines are observed within ATC for the RSO and OBS functions.

Declines occurred in all SAC functions, the greatest decline being in ADM. The decline overall was 4.4%.

Except in BHO, all TAC functions showed large overall declines. Overall, there was a decrease of 3,464 spaces, or 15.5%. The greatest reduction occurred in MIE, 43.4%. Since GRC has only DOD functional

TABLE B.1
AIR FORCE FUNCTIONAL ACCOUNT CODES BY DOD FUNCTIONAL CATEGORIES

DOD Functional Category	FACs Included
30 - Maintenance Repair of Real Property	44XX (less: 4400, 4401, 4402, 4406, 4410, 4425, 4426, 4427, 4461, 4463, 4466, 4467, 4490, 4491, 4492, 4493, 4494)
31 - Minor Construction	No manpower in this category
32 - Operation of Utilities for All Real Property	4461, 4463, 4466, 4467, 4491
33 - Other Engineering Support	4400, 4401, 4402, 4406, 4410, 4425, 4426, 4427, 4490, 4492, 4493, 4494
36 - Administration	10XX, 11XX, 12XX, 13XX, 14XX, 15XX, 16XX, 17XX, 18XX, 19XX
37 - Retail Supply Operations	125X, 41XX
38 - Maintenance of Installation Equipment	2XXX, 424X
39 - Other Base Services	30XX, 31XX, 32XX, 33XX, 34XX, 35XX, 36XX, 37XX, 38XX, 39XX, 40XX, 42XX, 43XX, 46XX, 47XX, 48XX, 49XX, 5XXX, 6XXX, 7XXX (less: 424X, 462X, 4650, 4651, 466X, 467X, 468X)
40 - Bachelor Housing and Furnishings	4650, 4651
41 - Morale, Welfare and Recreation	45XX
42 - Other Personnel Support	105X, 462X, 466X, 467X, 468X

TABLE B.2
FY78 MANPOWER DISTRIBUTIONS FOR EACH DOD FUNCTIONAL CATEGORY BY COMMAND

DOD Functional Categories	Command					
	ATC	Percent	SAC	Percent	TAC	Percent
ADM	4,607	31.1	7,049	24.4	5,180	27.5
RSO	3,027	20.4	7,900	27.4	5,208	27.7
MIE	652	4.4	2,179	7.5	1,236	6.6
OBS	3,069	20.7	7,822	27.1	4,427	23.6
MWR	542	3.7	903	3.1	625	3.3
BHO	241	1.6	332	1.1	239	1.3
OPS	<u>2,678</u>	<u>18.1</u>	<u>2,720</u>	<u>9.4</u>	<u>1,875</u>	<u>10.0</u>
Total	14,816	100.0	28,905	100.0	18,791	100.0

TABLE B.3
PERCENTAGE CHANGES IN MANPOWER FROM FY77 TO FY78 FOR EACH DOD FUNCTIONAL COMMAND BY CATEGORY

DOD Functional Categories	Manpower								
	1977 ATC	1978 ATC	% Change 77-78	1977 SAC	1978 SAC	% Change 77-78	1977 TAC	1978 TAC	% Change 77-78
ADM (36)	4,148	4,607	11.1	7,764	7,049	-9.2	5,624	5,180	-7.9
RSO (37)	3,103	3,027	-2.4	8,159	7,900	-3.3	6,133	5,208	-15.1
MIE (38)	522	652	13.4	2,225	2,179	-2.1	2,183	1,236	-43.4
OBS (39)	3,168	3,069	-3.1	8,049	7,822	-2.8	5,373	4,427	-17.6
MWR (41)	502	542	8.0	967	903	-6.6	666	626	-6.0
BHO (40)	200	241	20.5	338	332	-1.8	221	239	8.1
OPS (42)	<u>2,544</u>	<u>2,678</u>	5.3	<u>2,723</u>	<u>2,720</u>	-0.1	<u>2,055</u>	<u>1,875</u>	-8.8
Total	14,187	14,816	4.4	30,225	28,905	-4.4	22,255	18,791	-15.5

category manpower data, it is not known at this time why the declines were so large, nor is it known what specific functions were affected.

WORKLOAD ANALYSIS

Tables B.4 through B.6 present comparisons of workload indicators from 1977 to 1978 for ATC, SAC, and TAC, respectively. It is seen that major changes occurred in many indicators, particularly "total population supported," "total transactions," and "supply transactions," across all three commands. Also, it is observed that some of the largest percentage differences occurred for workload indicators where such differences would be least expected. For example, in ATC, total population supported decreased by 34% from 1977 to 1978, yet the total number of transactions processed increased by more than 26%. In addition, the number of dorm beds and available dorm space increased slightly, results which would not be expected with a decrease in population supported.

Conversely, while SAC and TAC showed increases in total population supported, total transactions, and supply transactions from 1977 to 1978, dorm beds and the number of square feet of dorm space decreased slightly in both commands.

There are several possible explanations for these discrepancies. We cannot be certain that the collected data are either totally accurate or complete for both years, and it is possible that at least some of the changes reflect errors in the data. Also, reporting practices may have changed from one year to the other, affecting the comparability of the data.

Certainly, some of the differences stem from variations in the period of reporting for the workload indicators. For example, the population indicators represent end of the fiscal year values, while the supply indicators are totals for only a 1-month period. In the case of aviation fuel consumption, the FY77 value is the actual 1-month total, while the FY78 figure is a monthly average of total consumption for a 4-month period. None of the monthly values for the individual workload

TABLE B.4
ATC WORKLOAD INDICATOR CHANGES

Indicator Name	FY77 Value	FY78 Value	% Difference FY77-FY78
<u>Administration Indicators:</u>			
Travel Transactions Processed	76,295	81,949	7.41
BOS Budget	472	484	2.54
Transactions Audited	-	-	-
Leave and Pay Accounts	-	-	-
Civilian Pay Records	-	-	-
Material and Services Transactions	-	-	-
<u>Population Indicators:</u>			
Total Population Supported (Including Dependents)	253,447	167,001	-34.10
Base Population	64,437	62,559	-2.91
BOS Population	14,187	14,816	4.43
Military Population	42,836	41,727	-2.59
Students	36,584	36,798	-4.99
Mission Population	50,250	47,743	-4.99
<u>Supply Indicators:</u>			
Total Transactions	1,011,220	1,277,155	26.30
Supply Transactions	818,579	1,062,509	29.80
Requisitions	43,654	66,740	24.39
Equipment Transactions	74,797	88,879	18.83
Receipts	64,190	59,027	-8.04
Total Inventory Item Records	394,925	453,401	14.81
Supply Item Records	(333,792)*	384,068	15.06
Equipment Item Records	61,133	69,334	13.41
Aviation Fuel Consumption	20,141	15,134	-24.87

* Not included originally in the 1977 data base.

TABLE B.4 (Continued)

<u>Indicator Name</u>	<u>FY77 Value</u>	<u>FY78 Value</u>	<u>% Difference FY77-FY78</u>
<u>Maintenance of Installation</u>			
<u>Equipment Indicators:</u>			
Total Vehicles	4,089	3,472	-15.09
Military Vehicles	-	1,080	-
Aircraft Tractors	-	40	-
Special Handling	-	1,040	-
Non-Military Vehicles	-	2,392	-
General Purpose Automobiles	-	478	-
All Purpose Trucks	-	1,914	-
<u>Bachelor Housing Indicators:</u>			
Square Feet of Dormitory Space	13,536	13,554	0.13
Dormitory Beds	61,903	62,114	0.34
<u>Other Personnel Support</u>			
<u>Indicators:</u>			
Weighted Rations Served	847,460	771,771	-8.93

TABLE B.5
SAC WORKLOAD INDICATOR CHANGES

Indicator Name	FY77 Value	FY78 Value	% Difference FY77-FY78
<u>Administration Indicators:</u>			
Travel Transactions Processed	109,753	106,779	-2.71
BOS Budget	890	882	-0.90
Transactions Audited	-	610,702	-
Leave and Pay Accounts	-	130,544	-
Civilian Pay Records	-	21,510	-
Material and Services Transactions	-	126,881	-
<u>Population Indicators:</u>			
Total Population Supported (Including Dependents)	344,002	412,551	19.93
Base Population	132,803	131,322	-1.12
BOS Population	30,225	28,905	-4.37
Military Population	111,674	111,643	-0.03
Mission Population	102,578	102,417	-0.16
<u>Supply Indicators:</u>			
Total Transactions	1,959,181	2,842,420	45.08
Supply Transactions	1,447,490	2,376,568	64.19
Requisitions	140,200	142,565	1.69
Equipment Transactions	220,092	193,415	-12.12
Receipts	151,399	129,872	-14.22
Total Inventory Item Records	1,079,322	1,084,387	-0.47
Supply Item Records	(923,286)*	921,863	-0.15
Equipment Item Records	156,036	162,524	4.16
Aviation Fuel Consumption	76,682	79,346	3.47
<u>Maintenance of Installation Equipment Indicators:</u>			
Total Mileage	681	880	29.22
Total Vehicle Equivalents	-	33,201	-

* Not included originally in the 1977 data base.

TABLE B.5 (Continued)

<u>Indicator Name</u>	<u>FY77 Value</u>	<u>FY78 Value</u>	<u>% Difference FY77-FY78</u>
Total Vehicles	15,084	14,601	-3.20
Military Vehicles	-	4,656	-
Aircraft Tractors	-	321	-
Special Handling	-	4,335	-
Non-Military Vehicles	-	9,945	-
General Purpose Automobiles	-	1,221	-
All Purpose Trucks	-	8,724	-
<u>Bachelor Housing Indicators:</u>			
Square Feet of Dormitory Space	10,719	9,395	-12.35
Dormitory Beds	48,049	41,837	-12.93
<u>Other Personnel Support Indicators:</u>			
Weighted Rations Served	398,382	456,186	14.51

TABLE B.6
TAC WORKLOAD INDICATOR CHANGES

Indicator Name	FY77 Value	FY78 Value	% Difference FY77-FY78
<u>Administration Indicators:</u>			
Travel Transactions Processed	88,527	84,562	-4.48
BOS Budget	526	570	8.37
Transactions Audited	-	425,233	-
Leave and Pay Accounts	-	99,647	-
Civilian Pay Records	-	14,978	-
Material and Services Transactions	-	87,098	-
<u>Population Indicators:</u>			
Total Population Supported (Including Dependents)	256,085	368,937	44.09
Base Population	95,635	98,039	2.51
BOS Population	22,255	18,791	-15.57
Military Population	82,202	84,645	2.97
Mission Population	73,380	79,248	8.00
<u>Supply Indicators:</u>			
Total Transactions	2,496,977	2,888,476	15.68
Supply Transactions	1,987,474	2,396,100	20.56
Requisitions	119,406	152,659	27.85
Equipment Transactions	252,252	220,525	-12.58
Receipts	137,845	119,192	-13.53
Total Inventory Item Records	901,803	929,105	3.03
Supply Item Records	(790,939)*	812,221	2.69
Equipment Item Records	110,864	116,884	5.43
Aviation Fuel Consumption	41,937	45,291	8.00

* Not included originally in the FY77 data base.

TABLE B.6 (Continued)

<u>Indicator Name</u>	<u>FY77 Value</u>	<u>FY78 Value</u>	<u>% Difference FY77-FY78</u>
<u>Maintenance of Installation</u>			
<u>Equipment Indicators:</u>			
Total Vehicles	11,434	11,347	-0.76
Military Vehicles	-	4,482	-
Aircraft Tractors	-	404	-
Special Handling	-	4,078	-
Non-Military Vehicles	-	6,865	-
General Purpose Automobiles	-	736	-
All Purpose Trucks	-	6,129	-
<u>Bachelor Housing Indicators:</u>			
Square Feet of Dormitory Space	7,373	6,881	-6.67
Dormitory Beds	33,847	32,138	-5.05
<u>Other Personnel Support</u>			
<u>Indicators:</u>			
Weighted Rations Served	305,784	344,877	12.78

indicators are necessarily obtained for the same month during each fiscal year. Thus, there remain substantial problems of both comparability and reliability of the values used for the model. Nonetheless, these values represent the best that were available at the time.

Additional discussion on data variability can be found in Appendix D, Analysis of Workload Interrelationships.

APPENDIX C

MANPOWER/WORKLOAD CORRELATION ANALYSIS

MANPOWER/WORKLOAD CORRELATION ANALYSIS

Tables C.1 through C.7 list the candidate workload measures that were tested for each of the seven manpower functional groupings. The workload variables tested included many which had been tested previously and which had shown significant correlations. Some variables which had been tested previously and had not shown significant correlations were not tested this time. Instead, other variables were substituted for testing as data for them became available.

Tables C.1 through C.7 include the correlation coefficients between functional manpower and the candidate workload measures. These coefficients give an indication of which workload measures are most closely related to aggregate manpower levels. There were 12 workload indicators tested for administration, 12 for retail supply, 14 for maintenance of installation equipment, four for other base services, two for morale, welfare and recreation, three for other personnel support, and three for bachelor housing operations. The following paragraphs summarize the findings for each of the functional groupings.

Administration (ADM). Seven population variables and five non-population variables were tested for administration. Only one variable, total contract manpower for SAC, does not correlate significantly to administration manpower. However, weak correlations for this workload variable are also noted for the other two commands. Correlations to the administration variable are strongest for base population with contract man-years in ATC, and total base officers in both SAC and TAC. As might be expected, total base population explains significant manpower variations across all three commands.

Retail Supply Operations (RSO). Supply transactions, supply item reports, total requisitions, total supply transactions, and total item records appear to be rather good estimators of retail supply manpower requirements. On the other hand, ground fuel consumption, equipment transactions, and total equipment transactions are poorer estimators of

TABLE C.1
MANPOWER/WORKLOAD CORRELATIONS FOR ADMINISTRATION (ADM)

Workload Indicator	Correlation Coefficient		
	ATC	SAC	TAC
Total Base Officers	.822	.968	.816
Total Base Civilians	.829	.572	.801
Total Contacts	.635	.236	.552
Total Travel Transactions	.866	.789	.713
Transactions Audited	.785	.754	.768
Total Air Force Members	.696	.921	.702
Service/Materiel Transactions	.898	.597	.699
BOS Budget	.805	.807	.708
Base Population	.908	.959	.753
Base Population with Contract Man-Years	.917	.946	.752
Total Base Airmen	.814	.864	.665
Military Population	.857	.909	.711
Civilian Pay Accounts	.865	.525	.732
5% Significance Level	.532	.388	.468

TABLE C.2
MANPOWER/WORKLOAD CORRELATIONS FOR
RETAIL SUPPLY OPERATIONS (RSO)

Workload Indicator	Correlation Coefficient		
	ATC	SAC	TAC
Ground Fuel Consumption	.485	.212	.335
Aviation Fuel	.465	.702	.750
Supply Transactions	.835	.768	.888
Equipment Transactions	.452	.386	.541
Supply Item Records	.776	.819	.926
Total Requisitions	.819	.687	.899
Total Dollar Value	.671	-.031	.590
Total Receipts	.749	.659	.916
Total Supply Transactions	.796	.647	.951
Total Equipment Transactions	.411	.349	.529
Total Item Records	.766	.749	.929
Base Population	.474	.574	.892
5% Significance Level	.532	.388	.497

TABLE C.3
MANPOWER/WORKLOAD CORRELATIONS FOR
MAINTENANCE OF INSTALLATION EQUIPMENT (MIE)

Workload Indicator	Correlation Coefficient		
	ATC	SAC	TAC
Aircraft Tractors	.272	.254	.299
General Purpose Automobiles	.648	.506	.474
All Purpose Trucks	.772	.829	.366
Special Handling Equipment-Warehouse	.724	.404	.546
Special Handling Equipment-Fire	-.047	.296	.092
Special Handling Equipment-Other	.708	.787	.231
Total Registered Vehicles	---	.837	---
Supply Transactions	.717	.254	.447
Equipment Transactions	.747	.514	.580
Base Population	.918	.409	.443
Total Vehicles	.716	.805	.236
Total Registered and Non-Registered Vehicles	---	.875	---
Total Vehicle Equivalents	---	.711	---
5% Significance Level	.553	.388	.468

TABLE C.4
MANPOWER/WORKLOAD CORRELATIONS FOR
OTHER BASE SERVICES (OBS)

Workload Indicator	Correlation Coefficient		
	ATC	SAC	TAC
Total Population Supported	.795	.922	.793
Total Air Traffic Control Operations	.303	.110	.172
Base Population	.802	.934	.668
Base Population with Contract Man-Years	.835	.918	.676
5% Significance Level	.497	.396	.468

TABLE C.5
MANPOWER/WORKLOAD CORRELATIONS FOR
MCRALE, WELFARE AND RECREATION (MWR)

Workload Indicator	Correlation Coefficient		
	ATC	SAC	TAC
Military Population	.860	.879	.701
Student Population	.856	---	---
5% Significance Level	.532	.388	.468

TABLE C.6
MANPOWER/WORKLOAD CORRELATIONS FOR
OTHER PERSONNEL SUPPORT (OPS)

Workload Indicators	Correlation Coefficient		
	ATC	SAC	TAC
Total Population Supported	.598	.080	.274
Base Population	.737	.301	.666
Weighted Rations Served	.986	.557	.698
Missile Base Factor for SAC	---	.896	---
Military Population	.777	.394	.670
5% Significance Level	.532	.388	.468

TABLE C.7
MANPOWER/WORKLOAD CORRELATIONS FOR
BACHELOR HOUSING OPERATIONS (BHO)

Workload Indicators	Correlation Coefficient		
	ATC	SAC	TAC
Dormitory Beds	.648	.361	.437
Square Feet of Dormitory Space	.713	.217	.578
Weighted Rations Served	.581	.110	.549
5% Significance Level	.532	.388	.468

retail supply manpower requirements. Interestingly, while the total dollar value variable indicates significant correlations for ATC and TAC, for SAC a negative correlation is indicated. This relationship may be caused by lack of stability in the variable for SAC. The data analyzed were for 1 month only, which may be too short a time period to measure such items.

Maintenance of Installation Equipment (MIE). The correlation coefficients which have been calculated for the three commands demonstrate the specialized function of TAC. Very few significant correlations are observed under MIE for TAC, probably reflecting the aircraft intensive nature of the TAC mission. For SAC, vehicle indicators such as total registered vehicles, total vehicles (registered and non-registered), total vehicle equivalents, and total annual mileage, proved to be the most significant indicators.

Other Base Services (OBS). Significant correlations are indicated for all categories of workload indicators except for total air traffic control operations for all three commands. It should be noted, however, that the correlation coefficients for TAC, even for those workload indicators that are significant, are generally less than the corresponding values for ATC and SAC. As has been noted previously, population variables are generally good estimators of other base services manpower.

Morale, Welfare and Recreation (MWR). As documented in previous GEBOS reports, population variables, particularly military population, continue to demonstrate a strong relationship to the MWR manpower function.

Other Personnel Support (OPS). Weighted rations served continues to show the strongest correlations across all commands for this functional grouping. Base population, weighted rations served, military population, and SAC bases with missile silos also show strong correlations for this grouping.

Bachelor Housing Operations (BHO). Dormitory beds and square feet of dormitory space show a correlation with BHO manpower for ATC and TAC, but not SAC. The poor correlations for SAC may be the result of a small number of manpower spaces per base (12.8) and a low coefficient of variation (S_y/\bar{Y}). The coefficient of variation for SAC BHO manpower is .326, less than half the value for either TAC (.682) or ATC (.785).

APPENDIX D

MANPOWER/WORKLOAD EQUATIONS

MANPOWER/WORKLOAD EQUATIONS

This appendix describes the recreation of the FY77 equations for FY78 data (where possible). The results of this are summarized below for each function.

ADMINISTRATION (Table D.1)

The base population and travel transactions proportion (i.e., travel transactions to service/material transactions) workload indicators were tested. Base population changed very little in value from the FY77 equations, remaining highly significant in all three of the FY78 equations. The travel transaction proportion indicator showed slightly greater significance in ATC and SAC, but ceased to be significant in TAC. However, the magnitude of the coefficients declined greatly in all three commands.

RETAIL SUPPLY OPERATIONS (Table D.2)

In each command, total transactions processed was the primary workload indicator. For ATC, the collinearity of total transactions with item records resulted in a significant overall regression, but low significance for individual coefficients.

For SAC, the significance and coefficients declined in the three workload indicators, R^2 , and both of the t-statistics, while the intercept increased.

The equation for TAC was very similar to the previous year, showing a large R^2 , but with only a slight decrease in the intercept and variable support coefficient.

MAINTENANCE OF INSTALLATION EQUIPMENT (Table D.3)

As was the case last year, insufficient data precluded the development of an equation for ATC. The situation, however, was different for SAC and TAC. Military vehicles and mileage proved to be significant for SAC, with increases in the intercept and mileage coefficients. For TAC, equipment item records were significant again.

TABLE D.1
ADMINISTRATION (ADM)
GEBOS FUNCTIONAL CATEGORY EQUATIONS

	FY77	FY78
<u>ATC</u>		
ADM = 60.6 + .0456(F71) + 220.3(F72)		ADM = 24.5 + .0469(F71) + 70.2(F72)
t statistic (8.55) (1.63)		t statistic (6.63) (1.66)
R ² = .950		R ² = .860
<u>SAC</u>		
ADM = 6.7 + .0500(G64) + 270.4(G72)		ADM = 31.6 + .0403(G64) + 36.2(G72)
t statistic (11.2) (1.57)		t statistic (17.6) (3.21)
R ² = .896		R ² = .944
<u>TAC</u>		
ADM = 12.2 + .0392(H64) + 473.4(H72)		ADM = 48.2 + .0433(H64) + 3.2(H72)
t statistic (4.18) (2.62)		t statistic (3.95) (0.11)
R ² = .832		R ² = .567
<u>Workload Indicators Selected:</u>		
64 Total Base Population		
71 Total Base Population (Less Students)		
72 Ratio of Travel Transactions to Service/Material Transactions (54/55)		

TABLE D.2
RETAIL SUPPLY OPERATIONS (RSO)
GEOS FUNCTIONAL CATEGORY EQUATIONS

	FY77	FY78
<u>ATC</u>		
RSO = 49.0 + .00096(F79) + .0032(F81)		RSO = 21.4 + .00177(F79) + .0010(F81)
t statistic (3.65) (5.48)		t statistic (1.46) (.33)
R ² = .864		R ² = .653
<u>SAC</u>		
RSO = 115.3 + .00157(G79) + 10.5(G80)		RSO = 187.4 + .00091(G79) + 2.10(G80)
t statistic (10.0) (3.57)		t statistic (4.24) (1.29)
R ² = .822		R ² = .452
<u>TAC</u>		
RSO = 141.2 + .00140(H79)		RSO = 124.0 + .00125(H79)
t statistic (12.0)		t statistic (10.2)
R ² = .911		R ² = .881
<u>Workload Indicators Selected:</u>		
79	Total Transactions (Requisitions, Receipts, Supply Transactions, Equipment Transactions)	
80	Item Records per \$1000 Inventory Value	
81	Total Item Records	

TABLE D.3
MAINTENANCE OF INSTALLATION EQUIPMENT (MIE)
GEBOS FUNCTIONAL CATEGORY EQUATIONS

	FY77	FY78
<u>ATC</u>		
Insufficient Data		
<u>SAC</u>		
MIE = $-19.1 + .30(G39) + .014(G40)$		MIE = $5.6 + .27(G39) + .0034(G40)$
t statistic (7.51) (1.67)		t statistic (4.21) (4.39)
R ² = .849		R ² = .720
<u>TAC</u>		
MIE = $-13.8 + .0194(H49)$		MIE = $6.6 + .0092(H49)$
t statistic (7.64)		t statistic (4.07)
R ² = .796		R ² = .525
<u>Workload Indicators Selected:</u>		
39 Military Vehicle Inventory		
40 Total Mileage (1000s)		
49 Equipment Item Records		

OTHER BASE SERVICES (Table D.4)

The total population supported was significant in all three commands; however, the intercepts increased for TAC.

MORALE, WELFARE AND RECREATION (Table D.5)

Military population, including student population for ATC, was highly significant again. Variable coefficients all remained virtually the same except for a noticeable decline in TAC.

OTHER PERSONNEL SUPPORT (Table D.6)

The equations for OPS remained essentially the same as the previous year, with all variables retaining their significance.

BACHELOR HOUSING OPERATIONS (Table D.7)

Dormitory beds was used in place of officers' quarters which was not available. The indicator was significant for ATC and TAC, but not SAC.

Some general observations on the FY78 recreation of the FY77 manpower/workload equations:

- Nineteen out of 20 equations had R^2 statistics significant at the 5% level.
- Twenty-six out of 31 workload indicators had significant t-statistics at the 5% level.
- Only four out of 20 R^2 statistics increased.
- Fourteen out of 31 workload indicator t-statistics showed an increase.
- Only 7 out of 28 directly comparable workload indicators showed a coefficient increase.
- Fifteen out of 20 equation constants increased.

The FY78 regression equations showed a continued overall explanatory significance, but declining fit when compared with FY77. This may

TABLE D.4
OTHER BASE SERVICES (OBS)
GEBOS FUNCTIONAL CATEGORY EQUATIONS

	FY77	FY78
<u>ATC</u>		
	OBS = 74.5 + .0070(F17)	OBS = 89.2 + .0139(F17)
	t statistic (8.91)	t statistic (4.55)
	R ² = .878	R ² = .633
<u>SAC</u>		
	OBS = 91.0 + .0143(G17)	OBS = 99.2 + .0121(G17)
	t statistic (16.8)	t statistic (11.4)
	R ² = .922	R ² = .850
<u>TAC</u>		
	OBS = 114.0 + .0102(H17)	OBS = 161.5 + .0045(H17)
	t statistic (8.29)	t statistic (4.69)
	R ² = .821	R ² = .629

Workload Indicator Selected:

17 Total Population Supported

TABLE D.5

MORALE, WELFARE AND RECREATION (MWR)
GEBOS FUNCTIONAL CATEGORY EQUATIONS

	FY77	FY78
<u>ATC</u>		
MWR = 11.8 + .0060(F12) + .0028(F32)		MWR = 16.7 + .0053(F12) + .0023(F32)
t statistic (2.45) (2.60)		t statistic (2.97) (2.89)
R ² = .845		R ² = .852
<u>SAC</u>		
MWR = 22.9 + .0033(G12)		MWR = 21.6 + .0031(G12)
t statistic (10.8)		t statistic (8.90)
R ² = .830		R ² = .775
<u>TAC</u>		
MWR = 25.1 + .0025(H12)		MWR = 27.3 + .0016(H12)
t statistic (5.83)		t statistic (3.80)
R ² = .694		R ² = .491
<u>Workload Indicators Selected</u>		
12 Total Military Population		
32 Student Population (ATC)		

TABLE D.6
OTHER PERSONNEL SUPPORT (OPS)
GEBOS FUNCTIONAL CATEGORY EQUATIONS

	FY77	FY78
<u>ATC</u>		
OPS = -35.3 + .0057(F17) + .0018(F42)		OPS = -6.0 + .0046(F17) + .0026(F42)
t statistic (2.30) (5.98)		t statistic (3.05) (22.1)
R ² = .972		R ² = .986
<u>SAC</u>		
OPS = 21.8 + .0016(G17) + .0023(G42) + 72.4(G44)		OPS = 34.2 + .0010(G17) + .0020(G42) + 80.3(G44)
t statistic (1.83) (2.41) (7.43)		t statistic (1.88) (2.71) (10.5)
R ² = .816		R ² = .892
<u>TAC</u>		
OPS = -7.2 + .0026(H17) + .0030(H42)		OPS = 29.6 + .0015(H17) + .0022(H42)
t statistic (1.87) (2.90)		t statistic (3.21) (3.49)
R ² = .759		R ² = .706
<u>Workload Indicators Selected:</u>		
17 Total Population Supported		
42 Weighted Ratios Served		
44 Missile Bases (SAC)		

TABLE D.7
BACHELOR HOUSING OPERATIONS (BHO)
GEBOS FUNCTIONAL CATEGORY EQUATIONS

	FY77	FY78
<u>ATC</u>		<u>ATC</u>
BHO = 10.8 + .050(F81)		BHO = 10.1 + .0013(F82)
t statistic (3.10)		t statistic (3.19)
R ² = .456		R ² = .420
<u>SAC</u>		<u>SAC</u>
BHO = 11.2 + .021(G81)		BHO = 16.7 + (-.0024)(G82)
t statistic (3.07)		t statistic (1.89)
R ² = .282		R ² = .130
<u>TAC</u>		<u>TAC</u>
BHO = 6.7 + .060(H81)		BHO = 5.2 + .0045(H82)
t statistic (3.95)		t statistic (1.95)
R ² = .566		R ² = .191
<u>Workload Indicators Selected:</u>		
81 Transient Officer Quarters		
82 Dormitory Beds		

be due to selection bias, since variables that predicted the best in FY77 may not necessarily be the best in FY78. Marginal productivity appeared to be on the increase since most workload coefficients experienced declining values.

Tables D.8 through D.10 list the manpower/workload equations developed for FY78. The number and types of workload indicators selected are generally similar to the FY77 indicators. The equations are listed here in their single base form. To convert the equations to command estimating equations, the single base intercept is adjusted to command figure. This was done by entering the command total workload (X) and total manpower (Y) into the equation, solving for the equation and solving for the command fixed functional manpower ($Y - bX$). This figure was usually the single base intercept times the number of bases, but could vary somewhat if data were missing for certain bases.

The regression intercepts provide an estimate of the base opening costs by function that can be compared to the base opening package planning factor. Table D.11 lists the functional regression intercepts for the three commands.

The total fixed manpower figures for SAC and TAC are reasonably close to the 436 planning factor. The ATC figure is considerably less, but the planning factor was based on a combat base rather than a training base. While the regression intercept is outside the statistical range of observation, it may be preferable to use information derived from it in modifying the planning factor.

Table D.12 presents regressions that were used to derive additional workload indicators. The regressions were both manpower workload relationships and workload interrelationships. The selection of the form for a particular workload indicator is somewhat arbitrary since two regressions usually are possible that relate additional descriptive indicators to either manpower or workload indicators used in the model.

TABLE D.8
ATC MANPOWER/WORKLOAD EQUATIONS

$$\text{ADM} = 78.9 + .0338(\text{Base Population}) + .0170(\text{Travel Transactions})$$

$$t \text{ statistic } (5.43) \qquad (4.17)$$

$$R^2 = .932$$

$$\text{RSO} = 32.9 + .00242(\text{Supply Transactions})$$

$$t \text{ statistic } (4.55)$$

$$R^2 = .633$$

$$\text{MIE} = 5.1 + .170(\text{Total Vehicles})$$

$$t \text{ statistic } (2.41)$$

$$R^2 = .327$$

$$\text{OBS} = 89.2 + .0139(\text{Total Population Supported})$$

$$t \text{ statistic } (8.25)$$

$$R^2 = .850$$

$$\text{MWR} = 16.7 + .0053(\text{Military Population}) + .0023(\text{Students})$$

$$t \text{ statistic } (2.97) \qquad (2.89)$$

$$R^2 = .852$$

$$\text{OPS} = -6.0 + .0046(\text{Total Population Supported}) + .0026(\text{Weighted Rations Served})$$

$$t \text{ statistic } (3.05) \qquad (22.1)$$

$$R^2 = .986$$

$$\text{BHO} = 11.0 + .0108(\text{Square Feet of Dormitory Space})$$

$$t \text{ statistic } (4.82)$$

$$R^2 = .659$$

TABLE D.9
SAC MANPOWER/WORKLOAD EQUATIONS

$$\text{ADM} = 56.4 + .0347(\text{Base Population}) + .00959(\text{Travel Transactions})$$

$$t \text{ statistic } (13.1) \quad (4.40)$$

$$R^2 = .957$$

$$\text{RSO} = 172.0 + .00297(\text{Supply Item Records}) + .00936(\text{Aviation Fuel Consumption})$$

$$t \text{ statistic } (6.14) \quad (3.98)$$

$$R^2 = .796$$

$$\text{MIE} = 5.6 + .270(\text{Military Vehicles}) + .8614(\text{Total Vehicle Mileage})$$

$$t \text{ statistic } (4.21) \quad (4.39)$$

$$R^2 = .720$$

$$\text{OBS} = 99.3 + .0121(\text{Total Population Supported})$$

$$t \text{ statistic } (11.4)$$

$$R^2 = .850$$

$$\text{MWR} = 21.6 + .0031(\text{Military Population})$$

$$t \text{ statistic } (8.90)$$

$$R^2 = .785$$

$$\text{OPS} = 48.1 + 80.3(\text{Base}) + .0010(\text{Total Population}) + .0020(\text{Weighted Rations})$$

$$t \text{ statistic } (10.5) \text{ Missile Factor } (1.88) \text{ Supported } (2.71) \text{ Served}$$

$$R^2 = .892$$

$$\text{BHO} = 10.9 + .00465(\text{Square Feet of Dormitory Space}) - 2.24(\text{Base}) + 17.9(\text{Missile Andersen})$$

$$t \text{ statistic } (1.25) \quad (2.01) \text{ Factor } (6.52)$$

$$R^2 = .712$$

Specification Used:

$$\text{BHO} = 10.9 + .0052(\text{Square Feet of Dormitory Space})$$

$$t \text{ statistic } (1.71)$$

$$R^2 = .203$$

TABLE D.10
TAC MANPOWER/WORKLOAD EQUATIONS

ADM = 25.8 + .0380(Base Population)+ .01015(Travel Transactions)		
t statistic	(2.71)	(1.29)
R ²	= .680	
RSO = 124.0 + .00125(Total Transactions Processed)		
t statistic	(10.2)	
R ²	= .881	
MIE = 35.4 + .8078(^{Aircraft} Tractors) + .0005996(^{Equipment} Transactions) + 51.9(Holloman)		
t statistic	(2.19)	(1.48) (3.66)
	+ 42.7(Howard) + 46.0(George)	
	(3.86)	(3.64)
R ²	= .767	
OBS = 161.5 + .0045(Total Population Supported)		
t statistic	(4.69)	
R ²	= 6.29	
MWR = 27.3 + .0016(Military Population)		
t statistic	(3.80)	
R ²	= .491	
OPS = 29.6 + .0015(^{Total Population} Supported) + .0022(^{Weighted} Rations Served)		
t statistic	(3.21)	(3.49)
R ²	= .706	
BHO = 1.9 + .0298(Square Feet of Dormitory Space)		
t statistic	(2.74)	
R ²	= .334	

TABLE D.11
FIXED BASE MANPOWER BY FUNCTION

Function	Command		
	ATC	SAC	TAC
Administration	78.9	56.4	25.8
Retail Supply Operations	32.9	172.0	124.0
Maintenance of Installation Equipment	5.1	5.6	35.4
Other Base Services	89.2	99.3	161.5
Morale, Welfare and Recreation	16.7	21.6	27.3
Other Personnel Support	0.0	48.1	29.6
Bachelor Housing Operations	<u>11.0</u>	<u>10.9</u>	<u>1.9</u>
Total	233.8	413.9	405.5

TABLE D.12
DESCRIPTIVE INDICATOR REGRESSIONS

Equation	R^2
<u>ATC</u>	
ADM = 23.5 + .885(BOS Budget)	.648
ADM = 47.0 + .011(Transactions Audited)	.616
ADM = 111.7 + .0293(Materiel and Services Transactions)	.806
RSO = 46.7 + .0050(Total Item Records)	.587
Aviation Fuel Consumption = 949.9 + 3.623(RSO)	
- 1463.8(Non-Pilot Training Base)	.725
BHO = 11.7 + .0024(Dormitory Beds)	.624
<u>SAC</u>	
BOS Budget = 184.5 + .0305(Base Population)	.704
ADM = 57.3 + .0090(Transactions Audited)	.568
ADM = 130.2 + .0247(Materiel and Services Transactions)	.356
Total Supply Transactions = -6340 + 2.883(Total Item Records)	.838
Dormitory Beds = 206.7 + 3.881(Square Feet of Dormitory Space)	.831
<u>TAC</u>	
ADM = -39.32 + .980(BOS Budget)	.502
ADM = -78.0 + .015(Transactions Audited)	.590
ADM = 30.1 + .0532(Materiel and Services Transactions)	.452
RSO = 126.1 + .0040(Total Item Records)	.863
RSO = 234.9 + .032(Aviation Fuel Consumption)	.562
Dormitory Beds = -30.6 + 4.75(Square Feet of Dormitory Space)	.958

The regression equations listed here undergo two transformations prior to their use in the model. First, the intercepts are adjusted, as was the case in the manpower/workload equations, to reflect command total manpower. Secondly, the equations are restated so that each descriptive indicator can be computed directly as a linear combination of an existing model output. For example, the regression for ATC that shows administration manpower as related to BOS budget is transformed into a relationship where BOS budget can be derived from a given level of administration manpower.

Additional descriptive indicators are computed as proportions of other primary indicators. For example, civilian pay records and leave and pay accounts were computed as proportions of total base population. Similarly, aggregate supply transactions and vehicle workload are broken down into detailed indicators based on FY78 proportions.

APPENDIX E

ANALYSIS OF WORKLOAD INTERRELATIONSHIPS

ANALYSIS OF WORKLOAD INTERRELATIONSHIPS

As a basis for further analysis, one of the first tasks performed in the development of the model was a determination of the variables for which there were relatively high correlation coefficients with other variables in the file. Using all of the relevant variables in the file, a correlation matrix was developed for each command. Table E.1 presents listings of the correlation coefficients, greater than or equal to .7, obtained for a series of dependent variables by each of the three commands.

As described in Appendix B, the supply indicators represent monthly rather than yearly values. Included in the file were actually two variables for each of three supply indicators (supply transactions, equipment transactions, and supply item records). The first set of variables (V22, V23, and V24) for the three indicators were provided by AFMEA for the month of September 1978. The second set (V28, V29, and V30) corresponding, respectively, to the first set were from data collected from other Air Force agencies in order to supplement and enhance the AFMEA data. These were obtained in October 1978 (see Appendix A). In general, it was this latter set of variables that was used in the computation of the workload equations. The reason for this is because the second set of variables was compatible with additional supply indicator variables collected by GRC. This permitted additional analysis of supply interrelationships.

In general, the supply transaction data for September and October were highly correlated. However, equipment transaction data fluctuated considerably, particularly for SAC and TAC. The correlation differences point out that the supply data, particularly the transaction data, are subject to short-term fluctuations in activity level.

Additional monthly variability was found in accounting and finance transactional data. Table E.2 provides the coefficients of variation (S_x/\bar{X}) for five accounting and finance indicators.

TABLE E.1

WORKLOAD CORRELATION COEFFICIENTS $\leq .7$, BY COMMAND

Dependent Variable	Predictor Variables and Correlation Coefficients		
	ATC	SAC	TAC
Base Population (X01)	V09 Travel Transactions	.787 V10 Transactions Audited	.706 V08 Total Contracts
	V10 Transactions Audited	.709 V11 Total Air Force Members	.976 V09 Travel Transactions
	V11 Total Air Force Members	.913 V16 BOS Budget	.837 V10 Transactions Audited
	V12 Civilian Pay Accounts	.801 V24 Supply Item Records	.742 V11 Total Air Force Members
	V14 Commercial Service Transactions	.741 V30 Total Item Records	.715 V12 Civilian Pay Accounts
	V16 BOS Budget	.745 V33 General Purpose Automobiles	.811 V14 Commercial Services Transactions
	V22 Supply Transactions	.703 V43 Total Population Supported	.865 tions
	V23 Equipment Transactions	.832 X05 Military Population	.967 V16 BOS Budget
	V24 Supply Item Records	.804	.929 V22 Supply Transactions
	V29 Total Equipment Transactions	.754	.863 V24 Supply Item Records
	V30 Total Item Records	.823	.831 V25 Total Requisitions
	V33 General Purpose Automobiles	.871	.802 V27 Total Receipts
	V34 All Purpose Trucks	.718	.854 V28 Total Supply Transactions
	V43 Total Population Supported	.966	.873 V30 Total Item Records
	V47 Square Feet Dorm Space	.723	.868 V33 General Purpose Automobiles
	X05 Military Population	.990	.729 V47 Square Feet Dorm Space
	X01 Base Population	.787 V10 Transactions Audited	.996 X05 Military Population
	V10 Transactions Audited	.979 V15 Account and Finance Workload	.834 V10 Transactions Audited
	V11 Total Air Force Members	.774 V43 Total Population Supported	.741 V22 Supply Transactions
	V12 Civilian Pay Accounts	.980	.725 V33 General Purpose Automobiles
	V14 Commercial Services Transactions	.954	.739 X01 Base Population
	V15 Account and Finance Workload	.841	.740 X05 Military Population
	V23 Equipment Transactions	.880	
	V29 Total Equipment Transactions	.933	
	V33 General Purpose Automobiles	.841	
	V43 Total Population Supported	.897	
	X05 Military Population	.706	
Transactions Audited (V10)	X01 Base Population	.709 X01 Base Population	.706 X01 Base Population
	V09 Travel Transactions	.979 V09 Travel Transactions	.856 V08 Total Contracts
	V11 Total Air Force Members	.757 V12 Civilian Pay Accounts	.830 V09 Travel Transactions
	V12 Civilian Pay Accounts	.951 V14 Commercial Service Transactions	.827 V12 Civilian Pay Accounts
	V14 Commercial Service Transactions	.954 tions	.714 V14 Commercial Service Transactions
	V15 Account and Finance Workload	.855 V15 Account and Finance Workload	.785 tions
	V23 Equipment Transactions	.781 V16 BOS Budget	.785 V16 BOS Budget
	V29 Total Equipment Transactions	.911 V33 General Purpose Automobiles	.884 V22 Supply Transactions
	V33 General Purpose Automobiles	.749	.792 V24 Supply Item Records
	V43 Total Population Supported	.827	.767 V25 Total Requisitions
			.782 V27 Total Receipts
			.799 V28 Total Supply Transactions
			.797 V30 Total Item Records
			.855 V33 General Purpose Automobiles
			.820 X05 Military Population
			.821 V11 Total Air Force Members

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables and Correlation Coefficients			
	AIC	SAC	TAC	
Air Force Members (V11)	X01 Base Population	.913	X01 Base Population	.976
	X09 Travel Transactions	.774	X16 BOS Budget	.748
	V10 Transactions Audited	.757	V24 Supply Item Records	.753
	V12 Civilian Pay Accounts	.743	V33 General Purpose Automobiles	.723
	V14 Commercial Service Transactions	.715	V43 Total Population Supported	.854
	V16 BOS Budget	.831	X05 Military Population	.983
	V24 Supply Item Records	.764		
	V27 Total Receipts	.730		
	V28 Total Supply Transactions	.716		
	V29 Total Equipment Transactions	.804		
	V30 Total Item Records	.794		
	V33 General Purpose Automobiles	.743		
	V34 All Purpose Trucks	.712		
	V37 Special Handling Equipment-Other	.823		
	V43 Total Population Supported	.887		
	V46 Dorm Beds	.910		
	V47 Square Feet Dorm Space	.929		
	X05 Military Population	.894		
	V50 Student Population	.874		
	Civilian Pay Accounts (V12)	X01 Base Population	.801	V10 Transactions Audited
V09 Travel Transactions		.980		
V10 Transactions Audited		.951		
V11 Total Air Force Members		.743		
V14 Commercial Service Transactions		.932		
V15 Account and Finance Workload		.881		
V23 Equipment Transactions		.903		
V29 Total Equipment Transactions		.909		
V33 General Purpose Automobiles		.872		
V43 Total Population Supported		.912		
Commercial Service Transactions (V14)		X01 Base Population	.741	V10 Transactions Audited
	X09 Travel Transactions	.954	V16 BOS Budget	.739
	V10 Transactions Audited	.954	V35 Special Handling Equipment-Warehouse	.735
	V11 Total Air Force Members	.715		
	V12 Civilian Pay Accounts	.932		
	V15 Account and Finance Workload	.786		
	V23 Equipment Transactions	.821		
	V29 Total Equipment Transactions	.816		
	V33 General Purpose Automobiles	.700		
	V43 Total Population Supported	.854		
	Material Account and Finance (V15)	V09 Travel Transactions	.841	V10 Transactions Audited
V10 Transactions Audited		.855	V09 Travel Transactions	.702
V12 Civilian Pay Accounts		.881	V16 BOS Budget	.724
V14 Commercial Service Transactions		.786		
V23 Equipment Transactions		.747		
V29 Total Equipment Transactions		.758		
V33 General Purpose Automobiles		.754		

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables and Correlation Coefficients			
	ATC	SAC	TAC	
BOS Budget (V16)	X01 Base Population	.745	X01 Base Population	.837
	V11 Total Air Force Members	.831	V08 Total Contracts	.914
	V28 Total Supply Transactions	.719	V10 Transactions Audited	.796
	V29 Total Equipment Transactions	.813	V11 Total Air Force Members	.785
	V30 Total Item Records	.702	V12 Civilian Pay Accounts	.929
	V33 General Purpose Automobiles	.753	V14 Commercial Services Transac-	.887
	V35 Special Handling Equipment--	.760	V14 Commercial Services Transac-	.767
	Warehouse		tions	
	V37 Special Handling Equipment--	.786	V21 Aviation Fuel	.735
	Other		V22 Supply Transactions	.885
	V43 Total Population Supported	.722	V24 Supply Item Records	.907
	V46 Dorm Beds	.801	V25 Total Requisitions	.847
	V47 Square Feet Dorm Space	.798	V27 Total Receipts	.864
	X05 Military Population	.722	V28 Total Supply Transactions	.880
	V50 Student Population	.788	V30 Total Item Records	.922
			V32 Aircraft Tractors	.789
			V33 General Purpose Automobiles	.873
			V46 Dorm Beds	.778
			V47 Square Feet Dorm Space	.828
			X05 Military Population	.898
Aviation Fuel Consumption (V21)	V26 Total Dollar Value	.763	V11 Total Air Force Members	.707
			V16 BOS Budget	.735
			V24 Supply Item Records	.760
			V25 Total Requisitions	.761
			V28 Total Supply Transactions	.772
Supply Transactions (V22)			V30 Total Item Records	.776
			V32 Aircraft Tractors	.823
	X01 Base Population	.703	X01 Base Population	.929
	V24 Supply Item Records	.917	V08 Total Contracts	.845
	V25 Total Requisitions	.899	V09 Travel Transactions	.741
	V26 Total Dollar Value	.736	V10 Transactions Audited	.884
	V27 Total Receipts	.889	V11 Total Air Force Members	.928
	V28 Total Supply Transactions	.900	V12 Civilian Pay Accounts	.800
	V30 Total Item Records	.919	V14 Commercial Services Transac-	.747
	V32 Aircraft Tractors	.723	tions	
	V34 All Purpose Trucks	.769	V16 BOS Budget	.885
	V35 Special Handling Equipment--	.783	V24 Supply Item Records	.868
	Warehouse		V25 Total Requisitions	.809
	X05 Military Population	.766	V27 Total Receipts	.873
			V28 Total Supply Transactions	.884
			V30 Total Item Records	.864
			V33 General Purpose Automobiles	.926
			X05 Military Population	.920

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables and Correlation Coefficient		
	ATC	SAC	TAC
Equipment Transactions (V23)	X01 Base Population	.832	None
	V09 Travel Transactions	.880	
	V10 Transactions Audited	.781	
	V12 Civilian Pay Accounts	.903	
	V14 Commercial Services Transactions	.821	
	V15 Account and Finance Workload	.747	
	V29 Total Equipment Transactions	.813	
	V33 General Purpose Automobiles	.919	
	V43 Total Population Supported	.906	
	X05 Military Population	.782	
Supply Item Records (V24)	X01 Base Population	.804	X01 Base Population
	V11 Total Air Force Members	.764	X08 Total Contracts
	V22 Supply Transactions	.917	V10 Transactions Audited
	V25 Total Requisitions	.878	V11 Total Air Force Members
	V26 Total Dollar Value	.771	V12 Civilian Pay Accounts
	V27 Total Receipts	.929	V14 Commercial Service Transactions
	V28 Total Supply Transactions	.928	V16 BOS Budget
	V30 Total Item Records	.997	V21 Aviation Fuel
	V34 All Purpose Trucks	.825	V22 Supply Transactions
	V37 Special Handling Equipment-Other	.746	V25 Total Requisitions
	X05 Military Population	.857	V27 Total Receipts
			V28 Total Supply Transactions
			V30 Total Item Records
			V32 Aircraft Tractors
			V33 General Purpose Automobiles
			V34 All Purpose Trucks
			V35 Special Handling Equipment-Warehouse
			V44 Air Traffic Control Operations
			V46 Dorm Beds
			V47 Square Feet Dorm Space
Total Requisitions (V25)	V22 Supply Transactions	.899	X01 Base Population
	V30 Total Item Records	.880	X08 Total Contracts
	V34 All Purpose Trucks	.786	V10 Transactions Audited
	V37 Special Handling Equipment-Other	.770	V11 Total Air Force Members
	V24 Supply Item Records	.878	V12 Civilian Pay Accounts
	V27 Total Receipts	.964	V16 BOS Budget
	V28 Total Supply Transactions	.933	V21 Aviation Fuel
	V35 Special Handling Equipment-Warehouse	.808	V22 Supply Transactions
			V24 Supply Item Records
			V27 Total Receipts
			V28 Total Supply Transactions
			V30 Total Item Records
			V33 General Purpose Automobiles
			V34 All Purpose Trucks
			V44 Air Traffic Control Operations
			V46 Dorm Beds
			V47 Square Feet Dorm Space
			X05 Military Population

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables and Correlation Coefficients			
	ATC	SAC	None	TAC
Total Dollar Value (V26)				
V21 Aviation Fuel	.763			
V22 Supply Transactions	.736			
V24 Supply Item Records	.771			
V27 Total Receipts	.706			
V30 Total Item Records	.741			
V32 Aircraft Tractors	.769			
Total Receipts (V27)				
V11 Total Air Force Members	.730	V21 Aviation Fuel	.718	X01 Base Population
V22 Supply Transactions	.889	V22 Supply Transactions	.791	V08 Total Contracts
V24 Supply Item Records	.929	V25 Total Requisitions	.942	V10 Transactions Audited
V25 Total Requisitions	.964	V28 Total Supply Transactions	.955	V11 Total Air Force Members
V26 Total Dollar Value	.706	V30 Total Item Records	.856	V12 Civilian Pay Accounts
V28 Total Supply Transactions	.953	V32 Aircraft Tractors	.703	V16 BOS Budget
V30 Total Item Records	.938			V22 Supply Transactions
V34 All Purpose Trucks	.754			V24 Supply Item Records
V35 Special Handling Equipment-Warehouse	.779			V25 Total Requisitions
V37 Special Handling Equipment-Other	.805			V28 Total Supply Transactions
X05 Military Population	.755			V30 Total Item Records
				V33 General Purpose Automobiles
				V34 All Purpose Trucks
				V35 Special Handling Equipment-Warehouse
				V44 Air Traffic Control Operations
				V46 Dorm Beds
				V47 Square Feet Dorm Space
				V48 Weighted Ratios Served
				X05 Military Population
Total Supply Transactions (V28)				
V11 Total Air Force Members	.716	V22 Supply Transactions	.771	X01 Base Population
V16 BOS Budget	.719	V25 Total Requisitions	.959	V08 Total Contracts
V22 Supply Transactions	.900	V27 Total Receipts	.955	V10 Transactions Audited
V24 Supply Item Records	.928	V29 Total Equipment Transactions	.753	V11 Total Air Force Members
V25 Total Requisitions	.933	V30 Total Item Records	.913	V12 Civilian Pay Accounts
V27 Total Receipts	.953	V32 Aircraft Tractors	.711	V16 BOS Budget
V30 Total Item Records	.926			V21 Aviation Fuel
V34 All Purpose Trucks	.748			V22 Supply Transactions
V35 Special Handling Equipment-Warehouse	.794			V24 Supply Item Records
V37 Special Handling Equipment-Other	.826			V25 Total Requisitions
X05 Military Population	.763			V27 Total Receipts
				V30 Total Item Records
				V32 Aircraft Tractors
				V33 General Purpose Automobiles
				V34 All Purpose Trucks
				V35 Special Handling Equipment-Warehouse
				V44 Air Traffic Control Operations
				V46 Dorm Beds
				V47 Square Feet Dorm Space
				X05 Military Population

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables and Correlation Coefficients					
	ATC	SAC		TAC		
Total Equipment Transactions (V29)	X01 Base Population	.754	V28 Total Supply Transactions	.753	V37 Special Handling Equipment--	.748
	V09 Travel Transactions	.933	V30 Total Item Records	.755	Other	
	V10 Transactions Audited	.911				
	V11 Total Air Force Members	.804				
	V12 Civilian Pay Accounts	.909				
	V14 Commercial Services Transactions	.816				
	V15 Account and Finance Workload	.758				
	V16 BOS Budget	.813				
	V23 Equipment Transactions	.813				
	V33 General Purpose Automobiles	.835				
	V43 Total Population Supported	.853				
	V47 Square Feet Dorm Space	.702				
	V50 Student Population	.710				
Total Item Records (V30)	X01 Base Population	.823	X01 Base Population	.715	X01 Base Population	.873
	V11 Total Air Force Members	.794	V22 Supply Transactions	.805	V08 Total Contracts	.768
	V16 BOS Budget	.702	V24 Supply Item Records	.784	V10 Transactions Audited	.797
	V22 Supply Transactions	.919	V25 Total Requisitions	.878	V11 Total Air Force Members	.906
	V24 Supply Item Records	.997	V27 Total Receipts	.856	V12 Civilian Pay Accounts	.812
	V25 Total Requisitions	.880	V28 Total Supply Transactions	.913	V16 BOS Budget	.922
	V26 Total Dollar Value	.741	V29 Total Equipment Transactions	.755	V21 Aviation Fuel	.776
	V27 Total Receipts	.938			V22 Supply Transactions	.864
	V28 Total Supply Transactions	.926			V24 Supply Item Records	.995
	V34 All Purpose Trucks	.825			V25 Total Requisitions	.941
	V37 Special Handling Equipment--Other	.759			V27 Total Receipts	.941
	V43 Total Population Supported	.705			V28 Total Supply Transactions	.978
	X05 Military Population	.872			V32 Aircraft Tractors	.733
					V33 General Purpose Automobiles	.803
					V34 All Purpose Trucks	.813
					V35 Special Handling Equipment--Warehouse	.727
					V44 Air Traffic Control Operations	.789
					V46 Dorm Beds	.777
					V47 Square Feet Dorm Space	.820
					X05 Military Population	.859
Aircraft Tractors (V32)	V22 Supply Transactions	.723	V22 Supply Transactions	.781	V08 Total Contracts	.701
	V26 Total Dollar Value	.769	V25 Total Requisitions	.775	V11 Total Air Force Members	.724
	V34 All Purpose Trucks	.719	V27 Total Receipts	.703	V16 BOS Budget	.789
			V28 Total Supply Transactions	.711	V21 Aviation Fuel	.823
					V24 Supply Item Records	.728
					V28 Total Supply Transactions	.711
					V30 Total Item Records	.733
					V46 Dorm Beds	.734
					V47 Square Feet Dorm Space	.759

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables and Correlation Coefficients			
	ATC	SAC	TAC	
General Purpose Automobiles (V33)	X01 Base Population	.871	X01 Base Population	.811
	X09 Total Travel Transactions	.841	X08 Total Contracts	.869
	X10 Transactions Audited	.749	X09 Travel Transactions Processed	.879
	X11 Total Air Force Members	.743	X10 Transactions Audited	.725
	X12 Civilian Pay Accounts	.872	X11 Total Air Force Members	.855
	X14 Commercial Services Transactions	.700	X12 Civilian Pay Accounts	.839
	X15 Account and Finance Workload	.754	X14 Commercial Services Transactions	.825
	X16 BOS Budget	.753	X15 Account and Finance Workload	.784
	X23 Equipment Transactions	.919	X16 BOS Budget	.873
	X29 Total Equipment Transactions	.835	X23 Equipment Transactions	.926
	X34 All Purpose Trucks	.713	X24 Supply Item Records	.806
	X43 Total Population Supported	.893	X25 Total Requisitions	.753
	X05 Military Population	.836	X27 Total Receipts	.829
			X28 Total Supply Transactions	.792
			X30 Total Item Records	.803
All Purpose Trucks (V34)	X01 Base Population	.718	X05 Military Population	.844
	X11 Total Air Force Members	.712		
	X22 Supply Transactions	.769	V24 Supply Item Records	.823
	X24 Supply Item Records	.825	V25 Total Requisitions	.833
	X25 Total Requisitions	.786	V27 Total Receipts	.781
	X27 Total Receipts	.754	V28 Total Supply Transactions	.795
	X28 Total Supply Transactions	.748	V30 Total Item Records	.813
	X30 Total Item Records	.825	V35 Special Handling Equipment-Warehouse	.742
	X32 Aircraft Tractors	.719	V37 Special Handling Equipment-Other	.806
	X33 General Purpose Automobiles	.713	V44 Air Traffic Control Operations	.707
	X35 Special Handling Equipment-Warehouse	.752		
	V37 Special Handling Equipment-Other	.822		
	X05 Military Population	.742		
Special Handling Equipment-Warehouse (V35)	X08 Total Contracts	.703	V14 Commercial Services Transaction	.735
	X16 BOS Budget	.760		
	X22 Supply Transactions	.783	V24 Supply Item Records	.765
	X25 Total Requisitions	.808	V27 Total Receipts	.790
	X27 Total Receipts	.779	V28 Total Supply Transactions	.744
	X28 Total Supply Transactions	.794	V30 Total Item Records	.727
	X34 All Purpose Trucks	.752	V34 All Purpose Trucks	.742
	V37 Special Handling Equipment-Other	.862	V36 Special Handling Equipment-Fire Fighting	.723
Special Handling Equipment-Fire (V36)	None	None	V35 Special Handling Equipment-Others	.723
Special Handling Equipment-Other (V37)	V11 Total Air Force Members	.823	V34 Special Handling Equipment-Fire Fighting	.789
	V16 BOS Budget	.786	V38 Total Registered Vehicles	.754
	V24 Supply Item Records	.746	V39 Total Registered and Non-Registered Vehicles	.754
	V25 Total Requisitions	.770	V40 Total Vehicle and Equivalents	.731
	V27 Total Receipts	.805		
	V28 Total Supply Transactions	.826		
	V30 Total Item Records	.759		
	V34 All Purpose Trucks	.822		

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables' and Correlation Coefficients		
	ATC	SAC	TAC
Special Handling Equipment-Other (V37) (Continued)	V35 Special Handling Equipment- Warehouse .862 V46 Dorm Beds .809 V47 Square Feet of Dorm Space .812 V50 Student Population .783		
Total Registered Vehicles (V38)	N/A	V34 All Purpose Trucks .950 N/A V37 Special Handling Equipment- Other .754 V39 Total Registered and Non- Registered Vehicles .978 V40 Total Vehicle Equivalents .912 V41 Total Annual Mileage .853	
Registered and Non- Registered Vehicles (V39)	N/A	V16 BOS Budget .717 N/A V34 All Purpose Trucks .929 V37 Special Handling Equipment- Other .754 V38 Total Registered Vehicles .980 V40 Total Vehicle Equivalent .924 V41 Total Annual Mileage .794	
Total Vehicle Equivalents (V40)	N/A	V34 All Purpose Trucks .857 N/A V37 Special Handling Equipment Other .731 V38 Total Registered Vehicles .912 V39 Total Registered and Non- Registered Vehicles .924 V41 Total Annual Mileage .720	
Total Population Supported (V43)	X01 Base Population .966 V09 Total Travel Transactions .897 V10 Transactions Audited .827 V11 Total Air Force Members .887 V12 Civilian Pay Accounts .912 V14 Commercial Service Trans- actions .854 V16 BOS Budget .722 V23 Equipment Transactions .906 V29 Total Equipment Trans- actions .853 V30 Total Item Records .705 V33 General Purpose Automobiles .893 X05 Military Population .923	X01 Base Population .865 N/A V09 Total Travel Transactions .740 V11 Total Air Force Members .854 V16 BOS Budget .768 X05 Military Population .845	

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables and Correlation Coefficients		
	ATC	SAC	TAC
Total Mileage (V4i)	N/A	V34 All Purpose Trucks .900 N/A V38 Total Registered Vehicles .853 V39 Total Registered and Non-Registered Vehicles .794 V40 Total Vehicle Equivalents .728	
Total Air Traffic Control Operations (V44)	None	None	V12 Civilian Pay Accounts .742 V24 Supply Item Records .802 V25 Total Requisitions .732 V27 Total Receipts .746 V28 Total Supply Transactions .734 V30 Total Item Records .789 V34 All Purpose Trucks .707
Dorm Beds (V46)	V11 Total Air Force Members .910 V16 BOS Budget .801 V37 Special Handling Equipment-Other .809 V47 Square Feet of Dorm Space .997 V50 Student Population .983	V47 Square Feet of Dorm Space .901	V16 BOS Budget .778 V24 Supply Item Records .759 V25 Total Requisitions .725 V27 Total Receipts .737 V28 Total Supply Transactions .749 V30 Total Item Records .777 V32 Aircraft Tractors .734 V47 Square Feet of Dorm Space .991 V48 Weighted Rations Served .815
Square Feet of Dorm Space (V47)	X01 Base Population .723 V11 Total Air Force Members .929 V16 BOS Budget .798 V29 Total Equipment Transactions .702 V37 Special Handling Equipment-Other .812 V46 Dorm Beds .997 X05 Military Population .703 V50 Student Population .977	V46 Dorm Beds .901	X01 Base Population .729 V11 Total Air Force Members .760 V16 BOS Budget .828 V24 Supply Item Records .803 V25 Total Requisitions .769 V27 Total Receipts .772 V28 Total Supply Transactions .794 V30 Total Item Records .820 V32 Aircraft Tractors .759 V46 Dorm Beds .991 V48 Weighted Rations Served .799 X05 Military Population .735

TABLE E.1 (Continued)

Dependent Variable	Predictor Variables and Correlation Coefficients			
	ATC	SAC	TAC	
Weighted Rations Served (V48)	N/A	None	V27 Total Receipts V46 Dorm Beds V47 Square Feet of Dorm Space	.720 .815 .799
Military Population (X05)	X01 Base Population V09 Travel Transactions Processed V11 Total Air Force Members V12 Civilian Pay Accounts V16 BOS Budget V22 Supply Transactions V23 Equipment Transactions V24 Supply Item Records V27 Total Receipts V28 Total Supply Transactions V30 Total Item Records V33 General Purpose Automobiles V43 Total Population Supported V47 Square Feet of Dorm Space V34 All Purpose Trucks	.990 .706 .894 .715 .722 .766 .782 .857 .755 .763 .872 .836 .923 .703 .742	X01 Base Population V11 Total Air Force Members V16 BOS Budget V33 General Purpose Automobiles V43 Total Population Supported	.967 .983 .739 .701 .845 .898 .920 .847 .829 .783 .847 .859 .844 .735
Student Population (V50)	V08 Total Contracts V11 Total Air Force Members V16 BOS Budget V29 Total Equipment Transactions V37 Special Handling Equipment- Other V46 Dorm Beds V47 Square Feet of Dorm Space	.707 .874 .788 .710 .783 .983 .977	N/A	N/A

TABLE E.2
ACCOUNTING AND FINANCE MONTHLY COEFFICIENTS OF VARIATION (s_x/\bar{x})

Indicator	ATC	SAC	TAC
Transactions Audited	10.18%	8.57%	11.78%
Members Serviced for Leave and Pay	4.19%	0.54%	3.62%
Civilian Pay Accounts	2.37%	4.66%	1.08%
Travel Transactions	10.94%	9.63%	15.20%
Commercial Services Transactions	14.89%	9.46%	12.44%

Two findings were made from the coefficient of variation analysis. First, the indicators most directly related to population figures, members serviced for leave and pay, and civilian pay accounts were the most stable over FY78. Both of these indicators had monthly fluctuations under 5%. The transactional data (audits, travel, and commercial services) experienced monthly variability in the 10% to 15% range for all three commands. Therefore, development of workload factors based on transactional data should use annualized data.

Several data sets suffer from the same basic deficiency, namely that they represent monthly totals rather than yearly totals. Despite our best efforts to obtain yearly totals for these indicators, the requested data are simply not maintained in such a way as to provide a yearly total. It would be helpful in any effort of this nature if yearly totals for these and other workload indicators were available in a centralized location. Although this would be a sizable project to undertake, there is a definite need for long-term data of this kind.

DERIVATION OF WORKLOAD EQUATIONS

Table E.3 presents for each command a listing of the workload equations and associated coefficients of determination (r^2) which are used in the model. The derivation of these equations was the result of extensive bivariate and multivariate regression analyses performed with the Statistical Package for the Social Sciences (SPSS). The equations used in the model were chosen on the basis of their yielding both a "best fit" and of having suitable high r^2 values.

Although most of the equations as presented are relatively straightforward, several notes on some of the equations are in order. In each command, the regression equations dealing with total population supported (V43) and military population (X05) with base population (X01), as well as square feet of dormitory space (V43) with military population in ATC, were converted into a form that yielded a zero intercept. This was done to avoid the logical difficulties of having equations in the model that would allow there to be, for instance, a military population at the base but no base population.

TABLE E.3
MODEL WORKLOAD EQUATIONS

	<u>ATC</u>	
1.	$V43 = 109.8 + 2.734(X01)$ Form Used: $V43 = 2.67(X01)$ $V43 = \text{Total Population Supported}$ $X01 = \text{Base Population}$	$r^2 = .949$
2.	$X05 = 434.1 + .5517(X01)$ Form Used: $X05 = .667(X01)$ $X05 = \text{Military Population}$ $X01 = \text{Base Population}$	$r^2 = .898$
3.	$X04 = 73.71 + .0713(X05)$ $X04 = \text{Total Vehicles}$ $X05 = \text{Military Population}$	$r^2 = .617$
4.	$V09 = 392.3 + .4605(V43)$ $V09 = \text{Total Travel Transactions}$ $V43 = \text{Total Population Supported}$	$r^2 = .569$
5.	$X05 = -828.4 + .6040(V47)$ Form Used: $V47 = .3248(X05)$ $X05 = \text{Military Population}$ $V47 = \text{Square Feet of Dormitory Space}$	Regression $r^2 = .621$
6.	$V28 = 32,784 + 15.36(X05)$ $V28 = \text{Total Supply Transactions}$ $X05 = \text{Military Population}$	$r^2 = .585$
7.	$V50 = .8259 + .05307(V48)$ $V50 = \text{Student Population}$ $V48 = \text{Weighted Rations Served}$	$r^2 = .948$
8.	$V48 = -1401 + 49.79(V47)$ $V48 = \text{Weighted Rations Served}$ $V47 = \text{Square Feet of Dormitory Space}$	$r^2 = .979$

TABLE E.3 (Continued)

	<u>SAC</u>	
1.	$V43 = 3347 + 2.59(X01)$ Form Used: $V43 = 3.14(X01)$ $V43 = \text{Total Population Supported}$ $X01 = \text{Base Population}$	$r^2 = .746$
2.	$X05 = -35.15 + .8573(X01)$ Form Used: $X05 = .850(X01)$ $X05 = \text{Military Population}$ $X01 = \text{Base Population}$	$r^2 = .935$
3.	$V48 = 11,848 + 1.128(X01)$ $V48 = \text{Weighted Rations Served}$ $X01 = \text{Base Population}$	$r^2 = .383$
4.	$V09 = -827.7 + .3034(V43)$ $V09 = \text{Total Travel Transactions}$ $V43 = \text{Total Population Supported}$	$r^2 = .557$
5.	$X01 = 551.2 + .158(V24)$ Transformed to: $V24 = -3488.8 + 6.329(X01)$ $X01 = \text{Base Population}$ $V24 = \text{Supply Item Records}$	$r^2 = .551$
6.	$V41 = -12.5 + .1193(X10)$ $V41 = \text{Total Mileage}$ $X10 = \text{Military Vehicles}$	$r^2 = .205$
7a.	$V21 = -120.8 + .08948(V24)$ $V21 = \text{Aviation Fuel}$ $V24 = \text{Supply Item Records}$ (Used in Model)	$r^2 = .191$
7b.	$V21 = 470.57 + 5779.37(D_1) + .07369(V24)$ $- 1103.18(\text{BASE } 1)$ $D_1 = \text{Castle AFB Factor}$ $V21 = \text{Aviation Fuel}$ $V24 = \text{Supply Item Records}$ $\text{BASE } 1 = \text{Missile Base Factor}$ (Best Statistical Fit)	$r^2 = .584$

TABLE E.3 (Continued)

8.	$V33 = .00503(X05) + 25.36$ V33 = General Purpose Automobiles X05 = Military Population	$r^2 = .456$
9.	$X10 = 3.813(V33)$ X10 = Military Vehicles Eq. 8 + Eq. 9 Yields: $X10 = .01918(X05) + 96.59$ (Used in Model)	$r^2 = .244$
<u>TAC</u>		
1.	$V43 = -4153.6 + 4.67(X01)$ Form Used: $V43 = 3.7637(X01)$ V43 = Total Population Supported X01 = Base Population	$r^2 = .616$
2.	$X05 = 184.98 + .8298(X01)$ Form Used: $X05 = .86338(X01)$ X05 = Military Population X01 = Base Population	$r^2 = .992$
3.	$V09 = -6.366 + .2123(V43)$ V09 = Total Travel Transactions V43 = Total Population Supported	$r^2 = .572$
4.	$X07 = 58,086 + 18.98(X01)$ X07 = Total Transactions Processed X01 = Base Population	$r^2 = .736$
5a.	$V23 = 2305 + 2.50284(V27)$	$r^2 = .373$
5b.	$V27 = 1806 + .88414(X01)$ Eq. 5a + Eq. 5b Yields: $V23 = 6825 + 2.2129(X01)$ V23 = Supply Transactions V27 = Total Receipts X01 = Base Population	$r^2 = .690$
6.	$V32 = 4.37 + .00384(X05)$ V32 = Aircraft Tractors X05 = Base Population	$r^2 = .512$

TABLE E.3 (Continued)

7.	$V47 = 85.64 + .0631(X05)$	$r^2 = .403$
	V47 = Square Feet of Dormitory Space	
	X05 = Military Population	
8.	$V48 = 5306.5 + 36.239(V47)$	$r^2 = .554$
	V48 = Weighted Rations Served	
	V47 = Square Feet of Dormitory Space	

On some occasions, when the derivation of one equation produced an r^2 value that was too low, two equations were used to derive the model equation. This was done for equations 8 and 9 in SAC, relating military vehicles (X10) to military population (X05) through general purpose automobiles (V33), and for equations 5a and 5b in TAC, relating supply transactions (V23) with base population (X01) through total receipts (V27). In this latter case, it should be noted that the interrelationship should have been established between total supply transactions (V29) and X01 rather than between V23 and X01. However, the equation as used provides a very close approximation to the "true" interrelationship.

Finally, although a regression of V21 with V24 and two dummy variables provided a better r^2 value, the bivariate relationship between V21 and V24 alone was used in the model.

APPENDIX F

GEBOS SYSTEM DOCUMENTATION

GEBOS SYSTEM DOCUMENTATION

GEBOS SYSTEM DIAGRAM

Figure F.1 presents a schematic diagram of the GEBOS system. The "core" of the system is the computer disk file containing the program BOSPG. This file is user-interactive, providing the user with the required prompts. Depending upon the responses to these prompts, BOSPG accesses the data contained in one or more of the command files (ATCFL, SACFL, or TACFL). Once the user has responded to all the relevant options requested by BOSPG, subroutine SUBLP is called by BOSPG. SUBLP then performs the actual model computations utilizing the data contained in the command files. BOSPG's output display format then prints the results of SUBLP's computations.

A complete listing of BOSPG is presented in Annex 1 to this appendix.

DESCRIPTION OF MODEL PARAMETERS

This section provides a detailed description of the model parameters using the ATC file as an example (other files are similar). This description uses the listing of ATCFL that is presented in Annex 2. The listings for SACFL and TACFL are presented in Annexes 3 and 4, respectively.

Line 20 contains the constant 1 and the total base opening manpower requirement.

Line 40 contains the label of the particular command to which the file pertains.

Line 60 contains a number of parameters necessary for use by the linear program. The first number (7) is the number of manpower functions contained in the file. Next comes the number of variables in the file (in this case, 24), which is the total of the number of individual manpower, workload, and slack variables. The number of equations (17) contained in the file comes next and, after that, comes the value of

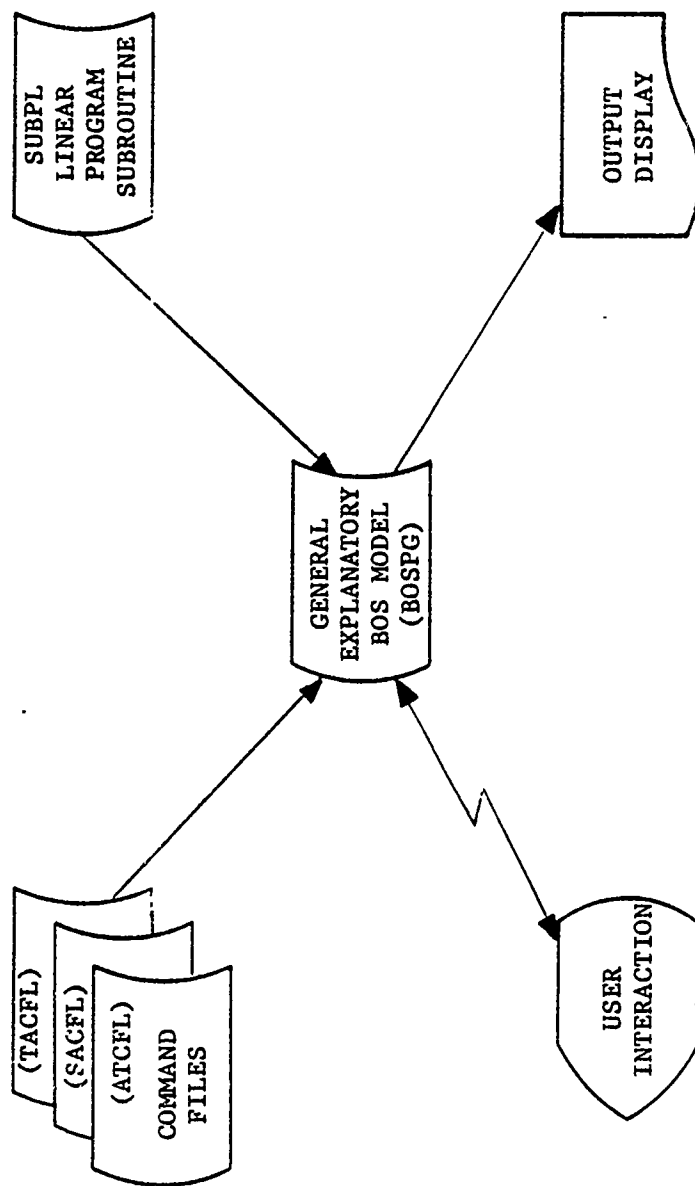


Figure F.1. Generalized Explanatory Base Operating Support Model Systems Diagram

epsilon (.001), which defines the precision of the linear program. Following this comes, respectively, the number (6) of workload indicator variables (other than the population variables) and the number of output display lines (42). The next number in this line (3) represents the number of manpower functions whose values are determined by the workload indicator variables. The last number in this line defines the number of workload equations that are included in the model.

The next 24 lines contain, in order, the FY78 values for the variables in the model. The first seven of these (lines 80-200) represent the values for the seven manpower functions, and the next seven lines (220-340) are the initial values of the slack variables (all zeroes in this case). The last 10 lines of this group (360-540) are the values for the workload variables.

The manpower functions are further described in lines 560-820. For each function, the variable name ("FADM," etc.), the percentage of military manpower within each function, the base opening cost (see Section 3), and, on the adjacent line, the label that describes the function are included.

The "heart" of the model is contained in lines 840-1200. It contains the objective function (line 840), the equation constants (line 860), and, then, the equations themselves (lines 880-1200). Each equation line (17 in all for this example) contains the coefficients to be used as multipliers of one or more of the 24 FY78 values contained in lines 80-540. Each column in the matrix represents, in order, one of the 24 variables. The position of the coefficients within each line indicates which of the variables is to be the multiplicand.

The linear program variables and equations must be set up in a specific order for the model to perform all options properly. The first constraint equation must be the total manpower constraint. The manpower workload equations come second. The final group of equations is the workload interrelationships. The first two workload interrelationship

equations must be the population interrelationships. These include the relationships between base population and total population supported, and between base population and military population.

The variables must be arranged by column in the same order they are specified in lines 80-540. That is, manpower functions, followed by manpower slack variables, and concluding with the workload indicators.

Line 1220 specifies which of the seven manpower functions have values that are determined by the workload indicator variables. The number of functions specified must agree with the number indicated in line 60.

Lines 1240 through 1460 show the positions (in the matrix) and labels of the workload indicators.

The remainder of the file specifies the equations of the remaining indicators (population, supply, etc.), their labels, as well as spacing information for the output display. Lines containing only a single zero (for example, lines 1480, 1880, etc.) indicate that the line to be output will not contain data. On the other hand, lines containing only a single 1 (such as 1520, 1580, etc.) indicate that the line to be output will contain both a label and data. Lines containing a series of numbers (1540, 1600, etc.) specify the linear equations of the various indicators. The numbers are the coefficients by which the variables are to be multiplied. Again, the positions of the coefficients indicate which of the variables is to be the multiplicand. The last (25th) number in each of these lines is the constant of the linear equation.

MODIFYING THE LINEAR PROGRAMMING FILES

As more data become available and as the need for refinements to the model arise, it will be necessary to modify the files for the three commands. Basically, there are four types of modifications which may be needed:

- Changing one or more of the linear program equations.
- Modifying the output display, such as adding or deleting a line.
- Adding one or more variables to the files.
- Combinations of the above.

Each of these types, except for the last, is discussed separately below.

Changing the Linear Program Equations

The matrix of linear program equations, derived from regression analyses, serves as a reference "standard" by which user-supplied changes in the manpower or workload variables may be measured. As better data become available or as more precise relationships among the variables become known, modifications to the linear equations will be needed.

Once the new relationships are known, it is a relatively simple matter to insert the changes into the linear program equation matrix. All that is needed is to replace the coefficients of the old equation with the coefficients of the new equation in their proper positions. Then, of course, the old constant for the equation must be replaced with the new constant in the line containing the constant values. In effect, then, only two lines need to be changed when an equation's coefficients are modified: the line containing the old coefficients and the line containing the constant for the old equation.

Further technical discussion on altering the linear program equations and testing for possible errors or inconsistencies is provided in Appendix G.

Modifying the Output Display

A somewhat more complicated situation occurs when it is desired to make changes to the output display such as when labels or spacing are modified. An example of this is presented in Annex 5. In this example, TACFL has been modified to include mission indicators among the

descriptive workload indicators (lines 3900-4040). This version of TACFL may be compared to that which was presented in Annex 4. Note that it is necessary to include all relevant directives for spacing and that the coefficients must appear in the proper positions. Also, it should be noted that line 60 must be modified to show the proper number of output display lines. In this example, the number of display lines was increased from 41 to 45.

Adding Variables to the Files

Conceptually, adding one or more variables to the file is very simple. However, the process of adding variables is difficult technically because it requires making modifications to each equation in the file on virtually a line-by-line basis. Each equation in the matrix must have the same number of columns as there are variables in the file, and an equation must be added to the matrix that defines the new variable in terms of the other variables. In addition, a column, with the appropriate coefficient, must be added to each of the descriptive workload indicators for each variable that is added to the file.

ANNEX 1

PROGRAM LISTING OF BOSPG


```

LIST 30SPG
30      INTEGER CMDS,CM3
40      DOUBLE PRECISION DASH,FNAM,CHAN,FILES,FILE,MP,WNAMS
60      DIMENSION OBEYW(4),OBEYW(4),OBEY(14),OBEY(4)
80      DIMENSION TOT(3),CMD(3),FILES(3)
100     DIMENSION PCTMIL(50),XMPONT(50),XPCNT(50),XTOT(3),XPP(50,3),
XPMIL(50,3),XWIND(50,50),XWS(50),CONST(50)
120     DIMENSION X(75),XBAR(50),DELX(50),C(50,50),MPIND(50),IFUNCS(
50),CSUMY(50),MOMIT(50),OBJ2(50)
140     DIMENSION PHS(50),OBJ(50),C2(50,50),PHS2(50),X2(75)
160     DIMENSION FUNC(50),FNAM(50,8),CHAN(8),MP(50,8),WNAMS(50,8)
180     DATA OBEYW // 'EQUATE 2 TOTSLF' /
200     DATA OBEYW // 'EQUATE 3 BOSLST' /
220     DATA OBEYW // 'EQUATE 1 BOSTMP' /
240     DATA FILES // 'ATCFL','SACFL','TACFL' /
260     DATA DASH // '*****' /
280     'A MANPOWER TOTAL FOR EACH COMMAND WILL NOW BE ENTERED FROM T
OTSFL.
300     CALL OBEY(OBEYW,4)
320     READ(2,*) (TOT(K),K=1,3)
340     PEWIND 2
360     CALL OBEY(OBEY,4)
380     CALL OBEY(OBEY,4)
400     LOOP=2
420     WRITE(6,9000) (DASH,K=1,16)
440     9000 FORMAT(16A5//24X,'AIP FORCE BASE OPERATING SUPPORT',2
460     23X,'AGGREGATE WORKLOAD INDICATOR MODEL')
480     10 CONTINUE
500     WRITE(6,9010) (DASH,K=1,16)
520     9010 FORMAT(//16A5//)
540     IF (LOOP.EQ.1) GO TO 55
560     'LOOP EQUALS "1" WHEN CHANGES ARE ACCUMULATED.
580     'THE COMMAND(S) REMAIN THE SAME.
600     WRITE(6,9020)
620     9020 FORMAT(1X,'ENTER COMMANDS (1=ATC,2=SAC,3=TAC):')
640     20 CONTINUE
660     READ(5,9030) (CMD(K),K=1,3)
680     9030 FORMAT(11,1X,11,1X,11)
700     CMDS=0
720     DO 30 K=1,3
740     IF (CMD(K).EQ.0) GO TO 30
760     IF (CMD(K).LT.1.OR.CMD(K).GT.3) GO TO 35
780     CMDS=CMDS+1
800     30 CONTINUE
820     IF (CMDS.GT.0) GO TO 40
840     35 CONTINUE
860     WRITE(6,9040)
880     9040 FORMAT(1X,'INVALID--ENTER 1,2, OR 3:')
900     GO TO 30
920     40 CONTINUE

```

```

940      NA VALID COMMAND HAS BEEN ENTERED.
960      %CMD EQUALS THE NUMBER OF COMMANDS BEING CHANGED.
980      %
1000     %THE TOTAL MANPOWER IS NOW COMPUTED (ALL COMMANDS).
1020     TOTS=0
1040     DO 50 K=1,CMD5
1060     TOTS=TOTS+TOT(CMD(K))
1080     50 CONTINUE
1100     55 CONTINUE
1120     NA LOOP IS SET UP TO RUN THROUGH DATA INPUT, CHANGE, AND PRINT
1140     %PROCEDURES FOR EACH COMMAND.
1160     DO 70 ICONT=1,CMD5
1180     %INITIALIZATION OF VARIABLES FOLLOWS.
1200     DO 60 K=1,50
1220     DELX(K)=0
1240     IFUNC(K)=0
1260     60 CONTINUE
1280     BASES=0
1300     ICOPT=0
1320     NFUNC=0
1340     IF (LOOP.EQ.2) GO TO 80
1360     DO 70 J=1,N
1380     %BAR(IJ)=X(IJ)
1400     70 CONTINUE
1420     GO TO 165
1440     80 CONTINUE
1460     %THE INPUT FILE WILL NOW BE DETERMINED: ATCFL, SACFL, OR TACFL

1480     FILE=FILES(CMD(ICONT))
1500     ENCODE(OBEYU,9050)FILE
1520     CALL OBEY(OBEYU,4)
1540     9050 FORMAT(10H:EQUATE 2 ,A5)
1560     %THE "X" VALUES, COEFFICIENTS, AND FUNCTION AND WORKLOAD INDICATOR TITLES
1580     %WILL NOW BE ENTERED. THE "Y" VALUES WILL BE COMPUTED FROM THE "X" VALUES.
1600     READ(2,*)%BASES,CSUM
1620     READ(2,9070)(CNAM(K),K=1,8)
1640     9070 FORMAT(1X,8A5)
1660     READ(2,*)M,N,M2,APG,N2,N3,M3,M4
1680     DO 85 J=1,N
1700     READ(2,*)%BAR(IJ)
1720     85 CONTINUE
1740     DO 90 I=1,M
1760     READ(2,*)IFUNC(I),PCTMIL(I),CSUMY(I)
1780     READ(2,9070)(FNAM(I,K),K=1,8)
1800     90 CONTINUE
1820     READ(2,*)%OBJ(I),J=1,N)
1840     OBJ2(N+1)=-1
1860     READ(2,*)%PHS(I),I=1,M2)
1880     MP1=M+1
1900     MPN=2*M
1920     M4=MPN+1
1940     DO 95 I=1,M2
1960     READ(2,*)%C(I,J),J=1,N)
1980     C2(I,N+1)=0
2000     95 CONTINUE
2020     C2(I,N+1)=1
2040     IF(N3.GT.0) READ(2,*)%MONIT(I),I=1,M3)
2060     DO 140 J=1,M2
2080     READ(2,*)%MPIND(I,J)

```

```

2100      READ(2,9070) (MP(J,K),K=1,8)
2120      140 CONTINUE
2140      %THE ARRAY MP CONTAINS TITLES FOR CHANGEABLE WORKLOAD INDICAT
ORS.
2160      DO 160 J=1,N3
2180      READ(2,*)WNS(J)
2200      IF(WNS(J).EQ.0)GO TO 150
2220      READ(2,*) (WIND(J,K),K=1,N),CONST(J)
2240      150 CONTINUE
2260      READ(2,9070) (WNAMS(J,K),K=1,8)
2280      160 CONTINUE
2300      %THE ARRAY WNAMS CONTAINS TITLES FOR THE PRINTED WORKLOAD IND
ICATORS.
2320      %IF WNS(J) EQUALS ZERO, THE TITLE IS A HEADER OF A SKIPPED LI
NE.
2340      %THE ARRAY WIND INDICATES THE COMBINATION OF THE ACTUAL WORKL
OAD INDICATORS
2360      %WHICH THE PRINTED LINE REPRESENTS.
2380      REWIND 2
2400      165 CONTINUE
2420      SUMY=0
2440      DO 167 I=1,M
2460      SUMY=SUMY+XBAR(I)
2480      167 CONTINUE
2500      RHS(1)=SUMY
2520      IF(CMDS.EQ.1)TOTS=SUMY
2540      YAMT=0
2560      USAGE=0
2580      IF(CMDS.EQ.1)GO TO 170
2600      %SPECIAL PROVISIONS MUST BE MADE FOR THE CHANGE OF MORE THAN
1 COMMAND:
2620      %FIRST, ONLY AN ABSOLUTE CHANGE MAY BE MADE, TO BE APPORTIONE
D TO ALL FUNCTIONS:
2640      %SECOND, NO WORKLOAD INDICATORS MAY BE CHANGED DIRECTLY:
2660      %THIRD, NO CHANGE IN THE NUMBER OF BASES MAY BE SPECIFIED:
2680      %FOURTH, NO ACCUMULATION OF CHANGES IS ALLOWED.
2700      IF(ICNT.EQ.1)GO TO 210
2720      %ON THE FIRST ITEPATION OF THE ICNT LOOP, THE ABSOLUTE CHANGE
WILL BE SPECIFIED.
2740      %ON SUCCESSIVE ITEPATIONS, THE SAME CHANGE IS APPLIED:
2760      %A PRINTOUT, BUT NO CHANGE OPTIONS, IS GIVEN.
2780      GO TO 398
2800      170 CONTINUE
2820      WRITE(6,9080)
2840      9080 FORMAT(/1X,'ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD)
:'')
2860      180 CONTINUE
2880      READ(5,*)IOPT
2900      GO TO (190,500),IOPT
2920      WRITE(6,9090)
2940      9090 FORMAT(/1X,'INVALID--ENTER 1 OR 2:')
2960      GO TO 180
2980      190 CONTINUE
3000      WRITE(6,9100)
3020      9100 FORMAT(/1X,'ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PE
CENT,3=NO OVERALL CHANGE SPEC.):')
3040      200 CONTINUE
3060      READ(5,*)ICOPT
3080      GO TO (210,240,260),ICOPT
3100      WRITE(6,9040)
3120      GO TO 200

```

```

3140      210 CONTINUE
3160      WRITE(6,9120)
3180      9120 FORMAT(/1X,'ENTER ABSOLUTE CHANGE:')
3200      220 CONTINUE
3220      READ(5,*)ABSCHG
3240      IF(TOTS+ABSCHG.GE.0)GO TO 230
3260      WRITE(6,9130)
3280      9130 FORMAT(/1X,'INVALID--CAUSES A NEGATIVE RESULTANT MANPOW
ER; RE-ENTER:')
3300      GO TO 220
3320      230 CONTINUE
3340      PRCNT=ABSCHG/TOTS
3360      :AFTER A VALID CHANGE IS ENTERED, IT IS CONVERTED TO A PERCENT
T FOR COMPUTATIONS.
3380      IF(CMDS.GT.1)GO TO 398
3400      GO TO 260
3420      240 CONTINUE
3440      WRITE(6,9140)
3460      9140 FORMAT(/1X,'ENTER PERCENT CHANGE:')
3480      250 CONTINUE
3500      READ(5,*)PPCNT
3520      IF(PRCNT.GE.-100.)GO TO 255
3540      WRITE(6,9150)
3560      GO TO 250
3580      255 CONTINUE
3600      PRCNT=PRCNT/100.
3620      260 CONTINUE
3640      WRITE(6,9150)
3660      9150 FORMAT(/1X,'ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHA
NGES WILL BE SPECIFIED:')
3680      270 CONTINUE
3700      READ(5,*)NFUNC
3720      IF(NFUNC.GT.0.AND.NFUNC.LE.M)GO TO 280
3740      IF(NFUNC.EQ.0)GO TO 360
3760      :WHEN NO FUNCTIONS ARE SPECIFIED, THE CHANGE IS APPORTIONED T
O ALL FUNCTIONS.
3780      WRITE(6,9160)M
3800      9160 FORMAT(/1X,'INVALID--ENTER FROM 1 TO ',I2,':')
3820      GO TO 270
3840      280 CONTINUE
3860      WRITE(6,9170)
3880      IF(ICOPT.NE.3)WRITE(6,9175)
3900      WRITE(6,9176)
3920      9170 FORMAT(/1X,'ENTER METHOD BY WHICH FUNCTION CHANGES WILL
BE SPECIFIED AS FOLLOWS:')
3940      4X,'1=ABSOLUTE NUMBER OF PEOPLE'//%
3960      4X,'2=PERCENT OF FUNCTION MANPOWER'//%
3980      4X,'3=PERCENT OF BOS MANPOWER')
4000      9175 FORMAT( 4X,'4=PERCENT OF TOTAL CHANGE')
4020      9176 FORMAT(/1X,'METHOD:')
4040      290 READ(5,*)METH
4060      IF(ICOPT.EQ.3)GO TO 295
4080      IF(METH.GT.0.AND.METH.LT.5)GO TO 300
4100      WRITE(6,9180)
4120      9180 FORMAT(/1X,'INVALID--ENTER 1,2,3, OR 4:')
4140      GO TO 290
4160      295 CONTINUE
4180      IF(METH.GT.0.AND.METH.LT.4)GO TO 300
4200      WRITE(6,9040)
4220      GO TO 290
4240      300 CONTINUE

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4260      WRITE(6,9190)
4280      9190 FORMAT(/1X,'ENTER FUNCTIONS AND ASSOCIATED CHANGES (ONE
FUNCTION PER LINE)')/2
4300      1X,'USING THE FOLLOWING NUMBERS TO DENOTE FUNCT
IONS:')
4320      DO 310 I=1,M
4340      WRITE(6,9200)I,IFNAM(I,K),K=1,8)
4360      9200 FORMAT(3X,I2,'=',8A5)
4380      310 CONTINUE
4400      WRITE(6,9210)
4420      9210 FORMAT(/)
4440      DO 350 I=1,NFUNC
4460      WRITE(6,9220)
4480      9220 FORMAT(1X,'FUNCTION,CHANGE:')
4500      320 CONTINUE
4520      READ(5,*)IFUNCS(I),AMOUNT
4540      IF(IFUNCS(I).GT.0.AND. IFUNCS(I).LE.M)GO TO 330
4560      WRITE(6,9230)
4580      9230 FORMAT(/1X,'INVALID FUNCTION--RE-ENTER FUNCTION AND CHA
NGE:')
4600      GO TO 320
4620      330 CONTINUE
4640      IF(METH.EQ.1)DELY=AMOUNT
4660      IF(METH.EQ.2)DELY=AMOUNT*XBAR(IFUNCS(I))/100.
4680      IF(METH.EQ.3)DELY=AMOUNT*SUMY/100.
4700      IF(METH.EQ.4)DELY=AMOUNT*PCNT*SUMY/100.
4720      %CHANGE IN "Y" IS COMPUTED USING METHOD OF CHANGE CHOSEN PREV
IOUSLY.
4740      IF(DELY*XBAR(IFUNCS(I)).GE.0)GO TO 340
4760      WRITE(6,9240)
4780      9240 FORMAT(/1X,'INVALID CHANGE--NEGATIVE RESULTANT MANPOWER
: RE-ENTER FUNCTION AND CHANGE:')
4800      GO TO 320
4820      340 CONTINUE
4840      USAGE=USAGE+DELY
4860      YAMT=YAMT+XBAR(IFUNCS(I))
4880      %IFUNCS(I)=XBAR(IFUNCS(I))+DELY
4900      350 CONTINUE
4920      360 CONTINUE
4940      WRITE(6,9250)
4960      9250 FORMAT(/1X,'IS THERE A CHANGE IN THE NUMBER OF BASES (1
=YES,2=NO)')
4980      370 CONTINUE
5000      READ(5,*)IOPT
5020      GO TO (380,398),IOPT
5040      WRITE(6,9090)
5060      GO TO 370
5080      380 CONTINUE
5100      WRITE(6,9270)
5120      9270 FORMAT(1X,'ENTER NUMBER OF BASES TO BE OPENED')+1 OF CLO
SED(-1)')
5140      READ(5,*)BASES
5160      DO 390 I=2,MP1
5180      IF(C(I,I-1).NE.0) PHS(I)=PHS(I)+BASES*CSUMY(I-1),C(I,I-1)
5200      390 CONTINUE
5220      398 CONTINUE
5240      M3APG=0
5260      M2APG=M2
5280      MAFG=M

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5300      IF(ICOPT.NE.3)GO TO 399
5320      NARG=N+1
5340      IF(YAMT.EQ.0)GO TO 400
5360      IF(USAGE/YAMT.GT.0)RHS(1)=PHS(1)+2*USAGE/YAMT*PHS(1)
5380      GO TO 400
5400      399 CONTINUE
5420      RHS(1)=RHS(1)+PPCNT*SUMY
5440      400 CONTINUE
5460      DO 401 J=1,N
5480      OBJ2(J)=OBJ(J)
5500      401 CONTINUE
5520      IF(NFUNC.EQ.0)GO TO 404
5540      402 CONTINUE
5560      DO 403 J=1,NFUNC
5580      OBJ2(IFUNCS(J))=0
5600      403 CONTINUE
5620      404 CONTINUE
5640      DO 415 I=1,M2ARG
5660      DO 405 J=1,N
5680      C2(I,J)=C(I,J)
5700      405 CONTINUE
5720      RHS2(I)=RHS(I)
5740      IF(NFUNC.EQ.0)GO TO 415
5760      DO 410 J=1,NFUNC
5780      C2(I,IFUNCS(J))=0
5800      RHS2(I)=RHS2(I)-C(I,IFUNCS(J))*Y(IFUNCS(J))
5820      410 CONTINUE
5840      415 CONTINUE
5860      IF(M3ARG.LE.0)GO TO 420
5880      IF(NINDS.EQ.0)GO TO 417
5900      IF(M3.EQ.0)GO TO 417
5920      DO 416 I=1,M3
5940      MI=MOMIT(I)
5960      RHS2(MI+1)=0
5980      DO 416 J=1,N
6000      C2(MI+1,J)=0
6020      416 CONTINUE
6040      417 CONTINUE
6060      C2(1,N4)=1
6080      RHS2(1)=-RHS2(1)
6100      DO 418 I=1,M2ARG
6120      DO 418 J=MP1,MPM
6140      C2(I,J)=0
6160      418 CONTINUE
6180      DO 419 I=1,M
6200      C2(1,I)=-C2(1,I)
6220      419 CONTINUE
6240      420 CONTINUE
6260      WRITE(1,*)NARG,M2ARG,ARG
6280      WRITE(1,*)(OBJ2(J),J=1,NARG)
6300      WRITE(1,*)(RHS2(I),I=1,M2ARG)
6320      DO 422 I=1,M2ARG
6340      WRITE(1,*)(C2(I,J),J=1,NARG)
6360      422 CONTINUE
6380      REWIND 1
6400      CALL SUBLP(N2,OPT)
6420      REWIND 1
6440      DO 427 J=1,N

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6480      IF (NFUNC.EQ.0) GO TO 426
6490      DO 425 I=1,NFUNC
6500      IF (IFUNCS(I).EQ.J) GO TO 427
6520      425 CONTINUE
6540      426 CONTINUE
6560      X(J)=X2(J)
6580      427 CONTINUE
6600      %ABOVE, THE ARGUMENTS FOR LINEAR PROGRAMMING ARE PREPARED.
6620      DO 450 J=1,N
6640      DELX(J)=X(J)-XBAR(J)
6660      450 CONTINUE
6680      GO TO 600
6700      %WORKLOAD OPTION FOLLOWS:
6720      500 CONTINUE
6740      WRITE(6,9275)
6760      9275 FORMAT(/1X,'ENTER CHANGE IN MISSION POPULATION (OP ZERO
TO RETAIN CURRENT VALUE):')
6780      READ(5,*)XVAL
6800      NARG=N
6820      M2ARG=M2
6840      M3ARG=1
6860      WRITE(6,9280)
6880      9280 FORMAT(/1X,'ENTER THE NUMBER OF WORKLOAD INDICATORS FOR
WHICH CHANGES WILL BE SPECIFIED:')
6900      510 CONTINUE
6920      READ(5,*)NINDS
6940      IF (NINDS.GT.0.AND.NINDS.LE.N2) GO TO 520
6960      IF (NINDS.EQ.0) GO TO 575
6980      WRITE(6,9160)N2
7000      GO TO 510
7020      520 CONTINUE
7040      WRITE(6,9290)
7060      9290 FORMAT(/1X,'ENTER WORKLOAD INDICATOR AND ASSOCIATED PER
CENT CHANGES (ONE INDICATOR'/'%
7080      1X,'PER LINE) USING THE FOLLOWING NUMBERS TO DE
NOTE WORKLOAD INDICATORS:')
7100      DO 530 J=1,N2
7120      WRITE(6,9200)J, (MP(J,K),K=1,8)
7140      530 CONTINUE
7160      WRITE(6,9210)
7180      DO 560 J=1,NINDS
7200      WRITE(6,9300)
7220      9300 FORMAT(1X,'WORKLOAD INDICATOR,CHANGE:')
7240      540 CONTINUE
7260      READ(5,*)INDW,PPCNT
7280      IF (INDW.GT.0.AND.INDW.LE.N2) GO TO 550
7300      WRITE(6,9310)
7320      9310 FORMAT(/1X,'INVALID WORKLOAD INDICATOR--RE-ENTER WORKLO
AD INDICATOR AND CHANGE:')
7340      GO TO 540
7360      550 CONTINUE
7380      DELX(MPIND(INDW))=PPCNT*XBAR(MPIND(INDW))/100
7400      %THE ACTUAL WORKLOAD INDICATOR WHICH THE USER SPECIFIES IS CH
ANGED.
7420      560 CONTINUE
7440      NFUNC=N2+N3
7460      DO 565 J=1,N2
7480      IFUNCS(J)=MPIND(J)
7500      X(MPIND(J))=XBAR(MPIND(J))+DELX(MPIND(J))

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7520      565 CONTINUE
7540      M2ARG=M4
7560      IF(M3.EQ.0)GO TO 575
7580      DO 570 J=1,M3
7600      MI=MOMIT(J)
7620      IFUNCS(J+N2)=MI
7640      X(MI)=RHS(MI+1)/C(MI+1,MI)
7660      DO 570 I=N4,N
7680      X(MI)=X(MI)-C(MI+1,I)*X(I)/C(MI+1,MI)
7700      570 CONTINUE
7720      575 CONTINUE
7740      RHS(1)=RHS(1)-XBAR(N4)-XVAL
7760      DO 580 J=1,M
7780      OBJ2(J)=1
7800      580 CONTINUE
7820      DO 590 J=MP1,MPM
7840      OBJ2(J)=0
7860      590 CONTINUE
7880      GO TO 402
7900      600 CONTINUE
7920      WRITE(6,9320)
7940      9320 FORMAT(/1X,'ENTER PRINT OPTION AS FOLLOWS:',//
7960              4X,'1=DISPLAY MILITARY/CIVILIAN BREAKOUT',//
7980              4X,'2=DISPLAY TOTAL MANPOWER ONLY',//
8000              1X,'PRINT OPTION IS:')
8020
8040      610 CONTINUE
8060      READ(5,*)IOPT
8080      IF(IOPT.GT.9.AND.IOPT.LT.3)GO TO 620
8100      IF(IOPT.EQ.199)STOP
8120      WRITE(6,9090)
8140      GO TO 610
8160      620 CONTINUE
8180      :THE TOTAL FUNCTIONAL MANPOWER PRINTOUT WILL NOW BE MADE.
8200      DO 630 K=1,3
8220      XTOT(K)=0
8240      630 CONTINUE
8260      WRITE(6,9330)
8280      9330 FORMAT(////)
8300      WRITE(6,9340)(CNAM(K),K=1,8)
8320      9340 FORMAT(31X,8A5//)
8340      WRITE(6,9350)
8360      9350 FORMAT(/29X,'FUNCTIONAL MANPOWER (TOTAL)',)
8380      WRITE(6,9360)
8400      9360 FORMAT(1X,'FUNCTION',36X,'FY78',6X,'CHANGE',1X,'RESULTA
NT',1X,'PERCENT'//
8420              43X,'MANPOWER',11X,'MANPOWER',2X,'CHANGE'//)
8440      DO 650 I=1,M
8460      XPCNT(I)=0
8480      IF(XBAR(I).NE.0) XPCNT(I)=DELX(I)/XBAR(I)*100.
8500      XPP(I,1)=XBAR(I)*XBASES
8520      XPP(I,2)=DELX(I)*XBASES
8540      XPP(I,3)=XPP(I,1)+XPP(I,2)
8560      DO 640 K=1,3
8580      XTOT(K)=XTOT(K)+XPP(I,K)
8600      640 CONTINUE
8620      WRITE(6,9370)(FNAM(I,K),K=1,8),(XPP(I,K),K=1,3),XPCNT(I)
8640      9370 FORMAT(1X,8A5,1X,F9.1,1X,F8.1,1X,F9.1,2X,F7.2)
8660      650 CONTINUE
8680      PCNT=0

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8680      IF(XTOT(1).NE.0)PCNT=XTOT(2)/XTOT(1)*100
8700      WRITE(6,9380)(XTOT(K),K=1,3),PCNT
8720      9380 FORMAT(/6X,'TOTAL',31X,F9.1,1X,F9.1,1X,F9.1,2X,F7.2)
8740      IF(IOPT.EQ.2)GO TO 715
8760      *THE MILITARY FUNCTIONAL MANPOWER PRINTOUT WILL NOW BE MADE.
8780      DO 660 K=1,3
8800      XTOT(K)=0
8820      660 CONTINUE
8840      WRITE(6,9330)
8860      WRITE(6,9390)
8880      9390 FORMAT(27X,'FUNCTIONAL MANPOWER (MILITARY)')
8900      WRITE(6,9360)
8920      DO 680 I=1,M
8940      XMPCNT(I)=PCTMIL(I)*XPCNT(I)/100.
8960      DO 670 K=1,3
8980      XMIL(I,K)=PCTMIL(I)*XPR(I,K)/100.
9000      XTOT(K)=XTOT(K)+XMIL(I,K)
9020      670 CONTINUE
9040      WRITE(6,9370)(FNAM(I,K),K=1,3),(XMIL(I,K),K=1,3),XMPCNT(I)
9060      680 CONTINUE
9080      PCNT=0
9100      IF(XTOT(1).NE.0)PCNT=XTOT(2)/XTOT(1)*100.
9120      WRITE(6,9380)(XTOT(K),K=1,3),PCNT
9140      *THE CIVILIAN FUNCTIONAL MANPOWER PRINTOUT WILL NOW BE MADE.
9160      DO 690 K=1,3
9180      XTOT(K)=0
9200      690 CONTINUE
9220      WRITE(6,9330)
9240      WRITE(6,9400)
9260      9400 FORMAT(27X,'FUNCTIONAL MANPOWER (CIVILIAN)')
9280      WRITE(6,9360)
9300      DO 710 I=1,M
9320      PCNT=XPCNT(I)-XMPCNT(I)
9340      DO 700 K=1,3
9360      XPR(I,K)=XPR(I,K)-XMIL(I,K)
9380      XTOT(K)=XTOT(K)+XPR(I,K)
9400      700 CONTINUE
9420      WRITE(6,9370)(FNAM(I,K),K=1,3),(XPR(I,K),K=1,3),PCNT
9440      710 CONTINUE
9460      PCNT=0
9480      IF(XTOT(1).NE.0)PCNT=XTOT(2)/XTOT(1)*100.
9500      WRITE(6,9380)(XTOT(K),K=1,3),PCNT
9520      715 CONTINUE
9540      *SLACK VARIABLES WILL NOW BE PRINTED.
9560      WRITE(6,9330)
9580      WRITE(6,9405)
9600      9405 FORMAT(30X,'MANPOWER SLACK VARIABLES')
9620      WRITE(6,9406)
9640      9406 FORMAT(11X,'FUNCTION',40X,'SLACK')
9660      DO 717 I=1,M
9680      WRITE(6,9407)(FNAM(I,K),K=1,3),X2(I,M)
9700      9407 FORMAT(1X,8A5,3X,F10.2)
9720      717 CONTINUE
9740      *THE WORKLOAD INDICATOR PRINTOUT WILL NOW BE MADE.
9760      WRITE(6,9330)
9780      WRITE(6,9410)
9800      9410 FORMAT(34X,'OUTPUT WORKLOAD')

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9820      WRITE(6,9420)
9840      9420 FORMAT(1X,'WORKLOAD INDICATOR',25X,'F178',7X,'CHANGE',1
X,'RESULTANT',2X,'PERCENT'//
9860      942X,'INDICATOR',11X,'INDICATOR',2X,'CHANGE'//)
9880      DO 740 I=1,N3
9900      XPR1=CONST(I)
9920      XPR2=0
9940      IF(WNS(I).GT.0)GO TO 720
9960      WRITE(6,9070)(WNAMS(I,K),K=1,8)
9980      GO TO 740
10000     720 CONTINUE
10020     DO 730 J=1,N
10040     XPR1=XPR1+XBASES*WIND(I,J)*XBAR(J)
10060     XPR2=XPR2+XBASES*WIND(I,J)*DELX(J)
10080     730 CONTINUE
10100     XPR3=XPR1+XPR2
10120     PCNT=0
10140     IF(XPR1.NE.0) PCNT=XPR2/XPR1*100.
10160     WRITE(6,9430)(WNAMS(I,K),K=1,8),XPR1,XPR2,XPR3,PCNT
10180     9430 FORMAT(1X,8A5,1X,F10.1,1X,F9.1,1X,F10.1,1X,F6.1)
10200     740 CONTINUE
10220     IF(BASES.EQ.0)GO TO 750
10240     ISUM=CSUM*BASES
10260     IB=BASES
10280     WRITE(6,9440)IB,ISUM
10300     9440 FORMAT(///1X,'THE CHANGE ACHIEVED BY OPENING ',I3,' BAS
E(S) IS ',I6)
10320     750 CONTINUE
10340     IF(ICNT.EQ.CMDS)GO TO 760
10360     WRITE(6,9010)(DASH,K=1,16)
10380     760 CONTINUE
10400     LOOP=2
10420     IF(CMDS.GT.1)GO TO 10
10440     WRITE(6,9450)
10460     9450 FORMAT(///1X,'ENTER ITERATION OPTION AS FOLLOWS:'//
10480     3X,'1=ACCUMULATE CHANGES,2=BEGIN NEW CYCLE,3=
STOP'//
10500     3X,'ITERATION OPTION=')
10520     770 CONTINUE
10540     READ(5,*)LOOP
10560     GO TO (10,10,780),LOOP
10580     WRITE(6,9040)
10600     GO TO 770
10620     780 CONTINUE
10640     STOP 'RUN COMPLETE'
10660     END

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ANNEX 2

LISTING OF FY78 MODEL PARAMETERS AND EQUATIONS
FOR THE AIR TRAINING COMMAND (ATCFL)

LIST ATCFL

20	1.436.
40	AIP TRAINING COMMAND
60	7. 24. 17. .001 6. 42. 3. 10.
80	4607.
100	3027.
120	652.
140	3069.
160	542.
180	2678.
200	241.
220	0.
240	0.
260	0.
280	0.
300	0.
320	0.
340	0.
360	62559.
380	0.
400	81949.
420	1062509.
440	3472.
460	167011.
480	13554.
500	41727.
520	36798.
540	771771.
560	'FADM' 59.37 0.
580	ADMINISTRATION
600	'FPSO' 58.18 165.
620	RETAIL SUPPLY OPERATIONS
640	'FMIE' 42.32 0.
660	MAINTENANCE OF INSTALLATION EQUIPMENT
680	'FOBS' 64.48 193.
700	OTHER BASE SERVICES
720	'FMWP' 54.30 0.
740	MORALE WELFARE & RECREATION
760	'FOPS' 13.52 78.
780	OTHER PERSONNEL SUPPORT
800	'FBHO' 44.13 0.
820	RECREATION HOUSING OPERATIONS

1480	1.	
1500	ADMINISTRATION INDICATORS:	
1520	1.	
1540	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0. 0.	
0. 0.		
1560	TRAVEL TRANSACTIONS PROCESSED	
1580	1.	
1600	.113 0. 0. 0. 0. 0. 0. 0. -.113 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0.	-37.	
1620	BOS BUDGET	
1640	1.	
1660	90.91 0. 0. 0. 0. 0. 0. 0. -90.91 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0.	-66194	
1680	TRANSACTIONS AUDITED	
1700	1.	
1720	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1.3195 0. 0. 0. 0. 0. 0.	
0. 0. 0.		
1740	LEAVE AND PAY ACCOUNTS	
1760	1.	
1780	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. .38543 0. 0. 0. 0. 0. 0.	
0. 0. 0.		
1800	CIVILIAN PAY RECORDS	
1820	1.	
1840	34.13 0. 0. 0. 0. 0. 0. 0. -34.13 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0.	-77446	
1860	MATERIAL & SERVICES TRANSACTIONS	
1880	0.	
1900		
1920	0.	
1940	POPULATION INDICATORS:	
1960	1.	
1980	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0.	
0. 0.		
2000	TOTAL POPULATION SUPPORTED (INCL DEP)	
2020	1.	
2040	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0. 0.	
0. 0.		
2060	BASE POPULATION	
2080	1.	
2100	1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0.		
2120	BOS POPULATION	
2140	1.	
2160	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0.	
0. 0.		
2180	MILITARY POPULATION	

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ANNEX 3

LISTING OF FY78 MODEL PARAMETERS AND EQUATIONS FOR
THE STRATEGIC AIR COMMAND (SACFL)

LIST SACFL

10	1,436.
20	STRATEGIC AIR COMMAND
30	7. 24. 17. .001 6. 43. 2. 10.
40	7049.
100	7900.
120	2179.
140	7822.
160	903.
180	2720.
200	332.
220	0.
240	0.
260	0.
280	0.
300	0.
320	0.
340	0.
360	131322.
380	106779.
400	921863.
420	79346.
440	4858.
460	880.
480	412551.
500	9395.
520	111643.
540	456126.
560	'GADN' 79.93 0.
580	ADMINISTRATION
600	'CP90' 80.20 165.
620	RETAIL SUPPLY OPERATIONS
640	'GNIE' 49.66 0.
660	MAINTENANCE OF INSTALLATION EQUIPMENT
680	'G036' 88.24 193.
700	OTHER BASE SERVICES
720	'GMWR' 65.56 0.
740	NOBILE WELFARE & RECREATION
760	'GOPS' 66.25 78.
780	OTHER PERSONNEL SUPPORT
800	'UNSH' 31.18 0.
820	SINGLEHOP HOUSING OPERATIONS

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2280	0.
2340	
2360	0.
2380	SUPPLY INDICATORS:
2400	1.
2420	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 3.387 0. 0. 0. 0. 0.
0. 0.	-279931.
2440	TOTAL TRANSACTIONS
2460	1.
2480	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 2.831894 0. 0. 0. 0.
0. 0. 0.	-234050.3091
2500	SUPPLY TRANSACTIONS
2520	1.
2540	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. .1698924 0. 0. 0. 0.
0. 0. 0.	-14052.5362
2560	PEQUISITIONS
2580	1.
2600	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. .23045757 0. 0. 0. 0.
0. 0. 0.	-19035.308
2620	EQUIPMENT TRANSACTIONS
2640	1.
2660	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. .1547571 0. 0. 0. 0.
0. 0. 0.	-12792.8467
2680	RECEIPTS
2700	1.
2720	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1.1763 0. 0. 0. 0. 0.
0. 0. 0.	
2740	TOTAL INVENTORY ITEM RECORDS
2760	1.
2780	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0.
0. 0.	
2800	SUPPLY ITEM RECORDS
2820	1.
2840	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. .1763 0. 0. 0. 0. 0.
0. 0. 0.	
2860	EQUIPMENT ITEM RECORDS
2880	1.
2900	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0.
0. 0.	
2920	AVIATION FUEL CONSUMPTION
2940	0.
2960	
2980	0.
3000	MAINT OF INSTA EQUIP INDICATORS:
3020	1.
3040	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0.
0. 0.	
3060	TOTAL MILEAGE

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3580	0.
3580	
3600	0.
3620	BACHELOR HOUSING INDICATORS:
3640	1.
3660	0. 0.

447856	0. 4395.
3680	SQ FT DORM SPACE
3700	1.
3720	0. 0.

73813	0. 22432.
3740	DORM BEDS
3760	0.
3780	
3800	0.
3820	OTHER PERSONNEL SUPPORT:
3840	1.
3860	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

1. 0.	
1080	WEIGHTED PATIONS SERVED

ANNEX 4

LISTING OF FY78 MODEL PARAMETERS AND EQUATIONS FOR
THE TACTICAL AIR COMMAND (TACFL)

LIST TACFL

20	1.436.
40	TACTICAL AIR COMMAND
60	7. 24. 17. .001 6. 41. 3. 10.
80	5180.
100	5208.
120	1238.
140	4427.
160	626.
180	1875.
200	239.
220	0.
240	0.
260	0.
280	0.
300	0.
320	0.
340	0.
360	98039.
380	84562.
400	2038476.
420	220525.
440	404.
460	368987.
480	6881.
500	84645.
520	344877.
540	0.
560	'HADM' 75.51 0.
580	ADMINISTRATION
600	'HRSO' 80.32 165.
620	PETAIL SUPPLY OPERATIONS
640	'HMIE' 75.81 0.
660	MAINTENANCE OF INSTALLATION EQUIPMENT
680	'HOBBS' 83.99 193.
700	OTHER BASE SERVICES
720	'HMWR' 62.30 0.
740	MORALE WELFARE & RECREATION
760	'HOPS' 56.00 73.
780	OTHER PERSONNEL SUPPORT
800	'PCHO' 34.82 0.
820	BACHELOR HOUSING OPERATIONS

1480	0.	
1500	ADMINISTRATION INDICATORS:	
1520	1.	
1540	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0. 0. 0.	
0. 0.		
1560	TRAVEL TRANSACTIONS PROCESSED	
1580	1.	
1600	.102 0. 0. 0. 0. 0. 0. 0. -.102 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0. -1.5		
1620	BOS BUDGET	
1640	1.	
1660	66.667 0. 0. 0. 0. 0. 0. 0. -66.667 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0. 0. 79898.		
1680	TRANSACTIONS AUDITED	
1700	1.	
1720	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1.0164 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0. 0.		
1740	LEAVE AND PAY ACCOUNTS	
1760	1.	
1780	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. .15273 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0. 0.		
1800	CIVILIAN PAY RECORDS	
1820	1.	
1840	22.33 0. 0. 0. 0. 0. 0. 0. -22.33 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0. 0. -31420.		
1860	MATERIAL & SERVICES TRANSACTIONS	
1880	0.	
1900	0.	
1920	0.	
1940	POPULATION INDICATORS:	
1960	1.	
1980	0. 1. 0. 0. 0.	
0. 0. 0.		
2000	TOTAL POPULATION SUPPORTED (INCL DEP)	
2020	1.	
2040	0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0.		
2060	BASE POPULATION	
2080	1.	
2100	1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0.		
2120	BOS POPULATION	
2140	1.	
2160	0. 1. 0. 0.	
0. 0.		
2180	MILITARY POPULATION	
2200	1.	
2220	-1. -1. -1. -1. -1. -1. -1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	
0. 0. 0. 0. 0.		
2240	MISSION POPULATION	

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ANNEX 5

LISTING OF TACFL MODIFIED TO INCLUDE MISSION INDICATORS

LIST TACFL

20	1,436.
40	TACTICAL AIR COMMAND
60	7. 24. 17. .001 6. 45. 3. 10.
80	5130.
100	5208.
120	1236.
140	4427.
160	626.
180	1975.
200	239.
220	0.
240	0.
260	0.
280	0.
300	0.
320	0.
340	0.
360	98039.
380	84562.
400	2883476.
420	220525.
440	404.
460	368987.
480	6881.
500	84645.
520	344877.
540	0.
560	'ADMN' 75.51 0.
580	ADMINISTRATION
600	'ARSO' 80.32 165.
620	RETAIL SUPPLY OPERATIONS
640	'AMIE' 75.81 0.
660	MAINTENANCE OF INSTALLATION EQUIPMENT
680	'HOSS' 83.99 195.
700	OTHER BASE SERVICES
720	'HNWR' 62.30 0.
740	MOBILE WELFARE & RECREATION
760	'HOPS' 56.00 78.
780	OTHER PERSONNEL SUPPORT
800	'HEHO' 34.62 0.
820	REACHELOR HOUSING OPERATIONS

840	0.0,0.0-0.0,0.0,0.0,0.0,0.0,-1,-1,-1,-1,-1,-1,-1,-1,-1.0
860	18791,-596.2137,-1597.425,-777.40989,-2766.5535,-490.568,-562
	.7901,-33.9462,0.0,-6226.0599,-1027695.73,-3574.4969,-73.709265,-1539.90
05,-95516.441,20000	
880	1.1,1,1,1,1,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0
900	-1.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,.038,.01015,0.0,0.0,0.0,0.0
920	0,-1.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,.00125,0.0,0.0,0.0,0.0
940	0.0,-1.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,.0005996,.3078262,0.0,0.0,0.
0	
960	0.0,0,-1.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,0.0,.0045,0.0,0.0
980	0.0,0,0,-1.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,0.0,.0016,0.0
1000	0.0,0,0,0,-1.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,.0015,0.0,.0022,0
1020	0.0,0,0,0,0,-1.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,.0298,0.0,0
1030	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,3.76367568,0.0,0.0,-1.0,0.0,0
1035	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,.8633808994,0.0,0.0,0.0,-1.0,0
1040	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,-1.0,0.0,.2123,0.0,0.0
1060	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,13.98,0,-1.0,0.0,0.0,0.0
1080	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,2.2129,0.0,-1.0,0.0,0.0,0
1100	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,-1.0,0,.003843,0.0
1160	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,-1,.0631,0.0
1180	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,36.239,0,-1.0
1200	0.0,0,0,0,0,0.0,0.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,0,-1
1220	2. 3. 7.
1240	16.
1260	TRAVEL TRANSACTIONS
1280	17.
1300	TOTAL TRANSACTIONS
1320	18.
1340	EQUIPMENT TRANSACTIONS
1360	19.
1380	AIRCRAFT TPACTORS
1400	21.
1420	50 FT DORM SPACE
1440	23.
1460	WEIGHTED RATINGS SERVED

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APPENDIX G

THE LINEAR PROGRAMMING MODEL

THE LINEAR PROGRAMMING MODEL

Linear programming is used as the computational methodology for solving the various manpower/workload problems in the GEBOS model. This appendix describes the linear programming subroutine.

The linear program can be run from GEBOS as a separate print option. Instead of the normal print options, the user enters "199." The actual equations used by the linear program can be listed by printing the data set "BOSTMP." The output of the linear program module is stored in the data set "BOSLST."

The linear programming problem as described in "BOSTMP" has the following format:

LINE 1: Number of variables, number of constraints, epsilon
(test for 0)
LINE 2: Objective function
LINE 3: Constraint constants
LINE 4 to END: Constraint variable coefficients

The number of variables in the problem includes slack and surplus variables. The current program can handle up to 50 variables and 25 constraints. Epsilon, a precision factor, provides the "0" test value. Any value less than epsilon is assumed to be 0. The objective function is stated for a minimization problem. Any objective function can be stated as a minimization problem. For example, the workload maximization problem can be stated as a minimization problem by changing the sign on the cost coefficients. Minimization of a negative quantity is identical to maximizing the positive value of such a quantity.

There are five subroutines involved in the linear program. They are:

- SUBLP
- MATGEN
- REITA
- RAWIA
- RIVO

The subroutines are listed as an annex to this appendix.

SUBLP is the central program. It solves the set of constraints using the revised simplex method. The first step is the generation of the initial working tableau, using the subroutine MATGEN. The next step is selection of the column with the lowest total price using subroutine REITA. The subroutine RAWIA selects the pivot column in the computations, while the subroutine RIVO performs the actual pivoting operation.

The program can terminate in four ways:

- Unbound solution
- Inconsistency
- Faulty processing
- Optimal solution

In an unbound solution the binding constraint is missing on one or more variables in the objective function and the model can keep increasing the objective function indefinitely without any restriction. An inconsistency occurs when two of the constraints are found to be in conflict, such as $x > 2$ along with $x < 1$. Faulty processing usually means there are missing constants, variables, or other contradictions with the parameter list. An optimal solution indicates processing was completed normally.

The general form of the output is the objective function total (Z), followed by the values for the model variables, in the order they were specified. If improper processing occurs, the appropriate cause of the problem is identified.

The particular linear programming solution search methodology used here sometimes results in "inconsistency" when it technically should not. Due to the nature of the equality constraints, the model sometimes goes through an intermediate step where one or more of the model variables is computed as negative. For example, due to other restrictions, dormitory space may be computed as negative in a particular pivoting. If such inconsistencies occur, they can be corrected through the derivation of additional constraints. These additional constraints, while redundant, prevent variables from being improperly computed outside a desired range during intermediate processing.

ANNEX 1

LISTINGS OF SUBROUTINES

SUBLP, MATGEN, REITA, RAWIA, AND RIVO


```

*LIST SUBLP
1      C  A PROGRAM FOR THE REVISED SIMPLEX METHOD
2      C  IT STORES THE INVERSE IN AN EXPLICIT FORM
3      C  THE OBJECTIVE FUNCTION IS TO BE MINIMIZED
3.5
4      SUBROUTINE SUBLP(X,OPT)
      COMMON/INFO/A(25,50),B(25,25),IBAS(25),M,M1,M2,N,N1,EPS
5      DIMENSION X(75)
6      DATA NREAD/1/,NPRINT/3/
7      C  GENERATE INITIAL TABLEAU
8      CALL MATGEN
9      C  CONSTRUCT THE FIRST WORKING TABLE AS AN M2*M2 TABLE
10     DO 19 I=3,M2
11     DO 18 J=2,M1
12     18 B(I,J)=0
13     B(I,I-1)=1
14     B(I,1)=A(I,1)
15     IBAS(I)=N+I-2
16     B(1,I-1)=0
17     19 B(2,I-1)=0
18     IBAS(1)=-1
19     IBAS(2)=0
20     B(1,1)=A(1,1)
21     B(2,1)=A(2,1)
22     C  START OF PHASE I
23     IPASE=1
24     C  CHOICE OF COLUMN WITH LOWEST PRICE
25     20 CALL REITA(IPASE,CD,JP)
26     IBU=JP-1
27     C  TRANSIT FROM PHASE I TO PHASE II
28     IF(CD+EPS)28,24,24

```

```

29      24 GO TO (25,45),IPASE
30      25 B(1,1)=B(1,1)
31          IF(B(1,1)-EPS)26,26,41
32      26 IPASE=2
33          GO TO 20
34      C   FORMATION OF THE EXTRA COLUMN AT THE EXTREME RIGHT OF THE 3 TABLE

35      28 GO TO (128,328),IPASE
36      128 DC=A(2,JP)
37          DO 228 I=3,M2
38      228 DC=DC+B(2,I-1)*A(I,JP)
39          B(2,M2)=DC
40      328 B(IPASE,M2)=CD
41          DO 30 I=3,M2
42          C=0
43          DO 29 J=3,M2
44      29 C=C+B(I,J-1)*A(J,JP)
45          B(I,M2)=C
46      30 CONTINUE
47      C   CHOOSE THE PIVOT COLUMN
48          CALL PAWIA(IP)
49          IF(IP)34,34,35
50      34 GO TO (52,37),IPASE
51      C   PERFORM THE PIVOTING OPERATION
52      35 CALL RIVO(IP,IPASE,IBU)
53          GO TO 20
54      C   PROBLEM RESULTS FOLLOW
55      C   A) UNBOUND SOLUTION
56      37 WRITE(NPRINT,3) IBU
57          DO 39 I=2,M2
58      39 WRITE(NPRINT,4) IBAS(I),B(I,1),B(I,M2)

```

```

59          GO TO 55
60      C   B) INCONSISTENCY
61          41 WRITE(NPRINT,6) B(1,1)+B(2,1)
62          NUAR=M+N
63          GO TO 47
64      C   C) OPTIMAL SOLUTION
65          45 OPT=B(2,1)
66          WRITE(NPRINT,7) OPT
67          NUAR=N
68      C   D) DETERMINATION OF THE X'S
69          47 DO 48 J=1,NUAR
70              48 X(J)=0
71              DO 49 I=3,M2
72                  IX=IBAS(I)
73                  49 X(IX)=B(I,1)
74      C   OUTPUT OPTIMAL SOLUTION
75          DO 2000 I=1,NUAR
76              WRITE(NPRINT,*)X(I)
77      2000 CONTINUE
78          GO TO 55
79      C   DISPLAY OF FAULTS (IF ANY)
80          52 WRITE(NPRINT,9) IPASE
81          55 WRITE(NPRINT,11)
82          RETURN
83          3 FORMAT(10X,'UNBOUND SOLUTION , X(' ,I2 ,')= INFINITY')
84          4 FORMAT(10X, 'X(' ,I2 ,')=' ,1PE20.8 ,2X,E20.8 ,'+T')
85          6 FORMAT(10X,'INCONSISTENT EQUATIONS, W=' ,1PE20.8 ,2X,' Z=' ,E20.8)
86          7 FORMAT('1' ,9X,'OPTIMAL SOLUTION', ' Z=' ,1PE20.8)
87          9 FORMAT(10X,'FAULTY PROCESSING IN PHASE',I2)
88          11 FORMAT(10X,'END OF CALCULATIONS')
89          END

```

```

139          SUBROUTINE MATGEN
140          COMMON/INFO/A(25,50),B(25,25),IBAS(25),M,M1,M2,N,N1,EPS
142          DATA NREAD/1/,NPRINT/3/
146          C    READ THE NUMBER OF VARIABLES,NUMBER OF CONSTRAINTS AND THE ACCU
PACTY
147          READ(NREAD,*) N,M,EPS
149          M1=M+1
150          M2=M+2
151          N1=N+1
152          C    READ COST COEFFICIENTS
153          READ(NREAD,*) (A(2,J),J=2,N1)
154          C    READ RHS
155          READ(NREAD,*) (A(I,1),I=3,M2)
156          C    INITIALIZE REMAINDER OF INPUT MATRIX
157          A(2,1)=0.0
158          DO 200 I=3,M2
159          READ(NREAD,*) (A(I,J),J=2,N1)
162          200 CONTINUE
177          C    END SPECIALIZED INITIALIZATION
178          C    INITIALIZE FIRST ROW
179          DO 1200 J=1,N1
180          C=0.0
181          DO 1100 I=3,M2
182          1100 C=C+A(I,J)
183          1200 A(1,J)=-C
187          RETURN
188          END

```

LIST PEITA

```
125      C  A SUBROUTINE TO CHOOSE THE COLUMN WITH THE LOWEST PRICE
126          SUBROUTINE PEITA(IPASE,CD,JP)
127          COMMON/INFO/A(25,50),B(25,25),IBAS(25),M,M1,M2,N,N1,EPS
128          CD=0
129          DO 23 J=2,N1
130              CDJ=A(IPASE,J)
131              DO 21 I=3,M2
132                  21 CDJ=CDJ+B(IPASE,I-1)*A(I,J)
133                  IF(CDJ-CD)22,23,23
134                  22 JP=J
135              CD=CDJ
136          23 CONTINUE
137          RETURN
138          END
```

```

ILIST PAWIA
  99      C  A SUBROUTINE TO CHOOSE PIVOT ROW
          SUBROUTINE RAWIA(IP)
100      COMMON/INFO/A(25,50),B(25,25),I3AS(25),M,M1,M2,N,N1,EPS
101      IP=-1
102      Q=1.0E+20
103      DO 33 I=3,M2
104      IF(B(I,M2))33,33,31
105      31 QI=B(I,1)/B(I,M2)
106      IF(QI-Q)32,33,33
107      32 Q=QI
108      IP=I
109      33 CONTINUE
110      RETURN
111      END

```

```

LIST RIUD
112      C  A SUBROUTINE TO PERFORM THE PIVOTING OPERATION
113      SUBROUTINE RIUD(IP,IPASE,IBU)
114      COMMON/INFO/A(25,50),B(25,25),IBAS(25),M,M1,M2,N,N1,EPS
115      PINU=1./B(IP,M2)
116      B(IP,M2)=0
117      DO 36 J=1,M1
118      C=B(IP,J)*PINU
119      B(IP,J)=C
120      DO 36 I=IPASE,M2
121      36 B(I,J)=B(I,J)-C*B(I,M2)
122      IBAS(IP)=IBU
123      RETURN
124      END

```

APPENDIX H
MODEL VALIDATION RUNS

MODEL VALIDATION RUNS

Following the development and testing of the model using the FY78 data and linear equations, it was necessary to perform validation runs for each of the three commands. Six basic procedures were used to validate the model:

1. Total BOS manpower was set at the FY77 value, allowing the other values to remain at FY78 levels. The model was used to calculate FY77 manpower by functions, primary workload indicators, and descriptive indicators.
2. Individual manpower function values were set at FY77 levels. The model calculated FY77 workload and descriptive indicator values.
3. Mission population was set at the FY77 level and the model calculated values for the other indicators.
4. Mission population and workload indicators were set to FY77 values and the model calculated values for BOS manpower and the descriptive indicators.
5. Values for the FY78 manpower variables and equations, as well as values for the FY78 workload variables, were replaced with their corresponding FY77 values. Total BOS manpower was then set at the FY78 level and the model computed FY78 values for manpower, workload, and the descriptive indicators. This procedure is sometimes referred to as working the model backwards.
6. Substituting the FY78 workload indicator values into the FY77 manpower equations, FY78 manpower values were calculated. These calculated values were then compared to the actual FY78 manpower values.

This appendix presents the results obtained when each of these procedures was used. The format of this appendix is arranged so that

each procedure is presented separately with tables for each command presented within each procedure. The actual model runs that produced these tables are presented in annexes to this appendix.

Procedure 1: Setting Only Total BOS Manpower to the FY77 Level

Tables H1 to H3 demonstrate the effect of reducing total FY78 BOS manpower to FY77 levels while leaving the FY78 equations and other parameters unchanged. The resulting values are what the model predicts for FY77 based upon the FY78 equations. These predicted FY77 values are then compared with the actual values (as known) in the tables.

ATC and TAC (Tables H1 and H3, respectively) both show considerable deviations for the computed values of MIE and BHO. TAC also shows a large variation for ADM. However, SAC (Table H2) shows little difference between the actual and predicted values. Large differences are noted for all three commands in the values for the indicators of total, supply, and equipment transactions. Although this may indicate the need for refinement of the equations for these indicators, it is suspected that the variability of the data for these indicators may be a contributing factor.

Large differences in each command are observed for total population supported and weighted rations served.

The model runs that computed the predicted FY77 values are presented in Annex 1.

TABLE H1

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES

USING FY78 MODEL EQUATIONS: TOTAL BOS MANPOWER SET AT FY77 LEVEL FOR ATC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	14187	14187	0	0.0
Administration	4148	4407	259	6.2
Retail Supply Operations	3103	2936	-167	-5.4
Maintenance of Installation Equipment	522	623	101	19.4
Other Base Services	3168	2934	-234	-7.4
Morale, Welfare, and Recreation	502	524	22	4.4
Other Personnel Support	2544	2531	-13	-0.5
Bachelor Housing Operations	200	232	32	16.0
<u>Primary Workload Indicators:</u>				
Base Population	64437	58904	5533	-8.6
Total Travel Transactions	76295	77465	-1170	1.5
Supply Transactions	818579	1025062	206483	25.2
Total Vehicles	4089	3298	-791	-19.4
Total Population Supported	253447	157274	-96173	-38.0
Square Feet of Dorm Space (Thousands)	13536	12761	-775	-5.7
Military Population	42836	39289	-3547	-8.3
Student Population	36584	34704	-1880	-5.1
Weighted Rations Served	847460	732291	-115169	-13.6
<u>Descriptive Indicators:</u>				
BOS Budget	472	461	-11	-2.3
Mission Population	50250	44717	-5533	-11.0
Total Transactions Processed	1011220	1232143	220923	21.9
Requisitions	53654	64388	10734	20.0
Equipment Transactions	74797	85747	10950	14.6
Receipts	64190	56947	-7243	-11.3
Total Inventory Item Records	394925	435277	40352	10.2
Equipment Item Records	61133	66562	5429	8.9
Aviation Fuel Consumption	20141	14804	-5337	-26.5
Dorm Beds	61903	58546	-3357	-5.4

TABLE H2

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES

USING FY78 MODEL EQUATIONS: TOTAL BOS MANPOWER SET AT FY77 LEVEL FOR SAC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
Manpower:				
Total BOS Manpower	30225	30225	0	0.0
Administration	7764	7531	-233	-3.0
Retail Supply Operations	8159	8165	6	0.1
Maintenance of Installation Equipment	2225	2245	20	0.9
Other Base Services	8049	8238	189	2.4
Morale, Welfare, and Recreation	967	932	-35	-3.6
Other Personnel Support	2723	2779	56	2.1
Bachelor Housing Operations	338	336	-2	-0.6
Primary Workload Indicators:				
Base Population	132803	142328	9525	7.2
Total Travel Transactions	109753	117204	7451	6.8
Aviation Fuel Consumption	76682	85577	8895	11.6
Total Mileage (Millions)	681	901	220	32.3
Total Population Supported	344002	446910	102908	29.9
Square Feet of Dorm Space (Thousands)	10719	9813	-906	-8.5
Military Population	111674	120979	9305	8.3
Weighted Rations Served	398382	468601	70219	17.6
Descriptive Indicators:				
BOS Budget	890	921	31	-3.5
Mission Population	102578	112103	9525	9.3
Total Transactions	1959181	3078289	1119108	57.1
Supply Transactions	1447490	2573780	1126290	77.8
Requisitions	140200	154396	14196	10.1
Equipment Transactions	220092	209464	-10628	-4.8
Receipts	151399	140649	-10750	-7.1
Total Inventory Item Records	1079322	1166305	86983	8.1
Equipment Item Records	156036	174802	18766	12.0
Total Vehicles	15084	15152	68	0.5
Dorm Beds	48049	43460	-4589	-9.6

TABLE H3

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES

USING FY78 MODEL EQUATIONS: TOTAL BOS MANPOWER SET AT FY77 LEVEL FOR TAC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	22255	22255	0	0.0
Administration	5624	6719	1095	19.5
Retail Supply Operations	6133	6000	-133	-2.2
Maintenance of Installation Equipment	2183	1370	-813	-37.2
Other Base Services	5373	4992	-381	-7.1
Morale, Welfare, and Recreation	666	672	6	0.9
Other Personnel Support	2055	2208	153	7.5
Bachelor Housing Operations	221	293	72	32.6
<u>Primary Workload Indicators:</u>				
Base Population	95635	131420	35785	37.4
Total Travel Transactions	88527	111234	22707	25.7
Total Transactions Processed	2496977	3522037	1025060	41.1
Equipment Transactions	252252	294393	42141	16.7
Total Population Supported	256085	494620	238535	93.2
Square Feet of Dorm Space (Thousands)	7373	8700	1327	18.0
Military Population	82202	113465	31263	38.0
Weighted Rations Served	305784	410779	104995	34.3
<u>Descriptive Indicators:</u>				
BOS Budget	526	727	201	38.2
Mission Population	73380	109164	35784	48.8
Supply Transactions	1987474	2898763	911289	45.9
Requisitions	119406	184684	65278	54.7
Receipts	137845	144197	6352	4.6
Total Inventory Item Records	901803	1127098	225295	25.0
Equipment Item Records	110864	141792	30928	27.9
Aviation Fuel Consumption	41937	70040	28103	67.0
Total Vehicles	11434	14458	3024	26.5
Dorm Beds	33847	40776	6929	20.5

Procedure 2: Setting Total BOS Manpower to the FY77 Level and Allocating
the Change to Each Manpower Function

Tables H4 to H6 are similar to the preceding tables except that the total BOS manpower change is allocated over each manpower function, setting each to its FY77 level for each command. Surprisingly, while the predicted values become more accurate for SAC and TAC, there is a noticeable reduction in accuracy for ATC although the calculated value of total population supported still shows a relatively large difference from the actual value in each command. Overall, however, this procedure seems to be preferable to allowing the model itself to allocate BOS manpower changes across the functions.

The model runs that produced Tables H4 through H6 are presented in Annex 2.

Tables H7, H8, and H9 present the slack manpower calculated for each manpower function within each command for the changes made in Tables H4 through H6.

TABLE H4

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES
 USING FY78 MODEL EQUATIONS: TOTAL FY77 BOS MANPOWER ALLOCATED TO EACH MANPOWER FUNCTION

FOR AIC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	14187	14187	0	0.0
Administration	4148	4148	0	0.0
Retail Supply Operations	3103	3103	0	0.0
Maintenance of Installation Equipment	522	522	0	0.0
Other Base Services	3168	3168	0	0.0
Morale, Welfare, and Recreation	502	502	0	0.0
Other Personnel Support	2544	2544	0	0.0
Bachelor Housing Operations	200	200	0	0.0
<u>Primary Workload Indicators:</u>				
Base Population	64437	45041	-19396	-30.1
Total Travel Transactions	76295	60419	-15876	-20.8
Supply Transactions	818579	883030	64451	7.9
Total Vehicles	4089	2639	-1450	-35.5
Total Population Supported	253447	120259	-133188	-52.6
Square Feet of Dorm Space (Thousands)	13536	9758	-3778	-27.9
Military Population	42836	30042	-12794	-29.9
Student Population	36584	26767	-9817	-26.8
Weighted Rations Served	847460	582753	-264707	-31.2
<u>Descriptive Indicators:</u>				
BOS Budget	472	375	-97	-20.6
Mission Population	50250	30854	-19396	-38.6
Total Transactions Processed	1011220	1061418	50198	4.6
Requisitions	53654	55466	1812	3.4
Equipment Transactions	74797	73866	-931	-1.2
Receipts	64190	49056	-15134	-23.6
Total Inventory Item Records	394925	366534	-28391	-7.2
Equipment Item Records	61133	56050	-5083	-8.3
Aviation Fuel Consumption	20141	15407	-4734	-23.5
Dorm Beds	61903	45030	-16873	-27.3

TABLE H5

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES
 USING FY78 MODEL EQUATIONS: TOTAL FY77 BOS MANPOWER ALLOCATED TO EACH MANPOWER FUNCTION

FOR SAC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
Manpower:				
Total BOS Manpower	30225	30225	0	0.0
Administration	7764	7764	0	0.0
Retail Supply Operations	8159	8159	0	0.0
Maintenance of Installation Equipment	2225	2225	0	0.0
Other Base Services	8049	8049	0	0.0
Morale, Welfare, and Recreation	967	967	0	0.0
Other Personnel Support	2723	2723	0	0.0
Bachelor Housing Operations	338	338	0	0.0
Primary Workload Indicators:				
Base Population	132803	131929	-874	-0.7
Total Travel Transactions	109753	107297	-2456	-2.2
Aviation Fuel Consumption	76682	79688	3006	3.9
Total Mileage (Millions)	681	881	200	29.4
Total Population Supported	344002	414258	70256	20.4
Square Feet of Dorm Space (Thousands)	10719	9417	-1302	-12.2
Military Population	111674	112140	466	0.4
Weighted Rations Served	398382	456871	58489	14.7
Descriptive Indicators:				
BOS Budget	890	884	-6	-0.7
Mission Population	102578	101704	-874	-0.9
Total Transactions	1959181	2855378	896197	45.7
Supply Transactions	1447490	2387403	939913	64.9
Requisitions	140200	143215	3015	2.2
Equipment Transactions	220092	194297	-25795	-11.7
Receipts	151399	130464	-20935	-13.8
Total Inventory Item Records	1079322	1088888	9566	0.9
Equipment Item Records	156036	163199	7163	4.6
Total Vehicles	15084	14621	-463	-3.1
Dorm Beds	48049	41923	-6126	-12.8

TABLE H6

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES
USING FY78 MODEL EQUATIONS: TOTAL FY77 BOS MANPOWER ALLOCATED TO EACH MANPOWER FUNCTION

FOR TAC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	22255	22255	0	0.0
Administration	5624	5624	0	0.0
Retail Supply Operations	6133	6133	0	0.0
Maintenance of Installation Equipment	2183	2183	0	0.0
Other Base Services	5373	5373	0	0.0
Morale, Welfare, and Recreation	666	666	0	0.0
Other Personnel Support	2055	2055	0	0.0
Bachelor Housing Operations	221	221	0	0.0
<u>Primary Workload Indicators:</u>				
Base Population	95635	86952	-8683	-9.1
Total Travel Transactions	88527	75703	-12824	-14.5
Total Transactions Processed	2496977	2678040	181063	7.3
Equipment Transactions	252252	195990	-56262	-22.3
Total Population Supported	256085	327258	71173	27.8
Square Feet of Dorm Space (Thousands)	7373	6277	-1096	-14.9
Military Population	82202	75073	-7129	-8.7
Weighted Rations Served	305784	322988	17204	5.6
<u>Descriptive Indicators:</u>				
BOS Budget	526	518	-8	-1.5
Mission Population	73380	64697	-8683	-11.8
Supply Transactions	1987474	2229141	241667	12.2
Requisitions	119406	142022	22616	18.9
Receipts	137845	110887	-26958	-19.6
Total Inventory Item Records	901803	863349	-38454	-4.3
Equipment Item Records	110864	108612	-2252	-2.0
Aviation Fuel Consumption	41937	37071	-4866	-11.6
Total Vehicles	11434	10314	-1120	-9.8
Dorm Beds	33847	29269	-4578	-13.5

TABLE H7
SLACK MANPOWER FROM INPUT OF FY77 ACTUAL MANPOWER
DISTRIBUTION FOR ATC

MANPOWER FUNCTION	ACTUAL FY77 MANPOWER	ACTUAL FY78 MANPOWER	DIFFERENCE FY77-FY78	CALCULATED SLACK MANPOWER
ADMINISTRATION	4148	4607	459	499
RETAIL SUPPLY OPERATIONS	3103	3027	-76	510
MAINT. OF INSTALLATION EQUIP.	522	652	130	12
OTHER BASE SERVICES	3168	3069	-99	749
MORALE, WELFARE & RECREATION	502	542	40	45
OTHER PERSONNEL SUPPORT	2544	2678	134	573
BACHELOR HOUSING OPERATIONS	200	241	41	0
TOTAL	14187	14816	629	--

TABLE H8
SLACK MANPOWER FROM INPUT OF FY77 ACTUAL MANPOWER
DISTRIBUTION FOR SAC

MANPOWER FUNCTION	ACTUAL FY77 MANPOWER	ACTUAL FY78 MANPOWER	DIFFERENCE FY77-FY78	CALCULATED SLACK MANPOWER
ADMINISTRATION	7764	7049	-715	689
RETAIL SUPPLY OPERATIONS	8159	7900	-259	245
MAINT. OF INSTALLATION EQUIP.	2225	2179	-46	44
OTHER BASE SERVICES	8049	7822	-227	206
MOBILE, WELFARE & RECREATION	967	903	-64	62
OTHER PERSONNEL SUPPORT	2723	2720	-3	0
BACHELOR HOUSING OPERATIONS	338	332	-6	6
TOTAL	30225	28905	-1320	--

TABLE H9
SLACK MANPOWER FROM INPUT OF FY77 ACTUAL MANPOWER
DISTRIBUTION FOR TAC

MANPOWER FUNCTION	ACTUAL FY77 MANPOWER	ACTUAL FY78 MANPOWER	DIFFERENCE FY77-FY78	CALCULATED SLACK MANPOWER
ADMINISTRATION	5624	5180	-444	955
RETAIL SUPPLY OPERATIONS	6133	5208	-925	1188
MAINT. OF INSTALLATION EQUIP.	2183	1236	-947	991
OTHER BASE SERVICES	5373	4427	-946	1134
MORALE, WELFARE, RECREATION	666	626	-40	55
OTHER PERSONNEL SUPPORT	2055	1875	-180	291
BACHELOR HOUSING OPERATIONS	221	239	18	0
TOTAL	22255	18791	- 3464	--

Procedure 3: Setting Only Mission Population to the FY77 Level

When the workload option is chosen, the user has the ability to control the value of mission population being input to the model. Tables H10 through H12 show the results obtained when mission population alone is set at the 1977 level. Again, the predicted values for transaction indicators and total population supported vary greatly from actual values in all three commands.

The predicted manpower values for SAC show the least discrepancy from actual FY77 manpower values while ATC and TAC show some rather large differences (over 10%) in many of the manpower functions.

The model runs that produced the predicted values for Tables H10, H11, and H12 are included in Annex 3.

TABLE H10

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES USING
FY78 MODEL EQUATIONS: MISSION POPULATION SET AT FY77 LEVEL FOR ATC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	14187	15338	1151	8.1
Administration	4148	4773	625	15.1
Retail Supply Operations	3103	3102	-1	0.0
Maintenance of Installation Equipment	522	677	155	29.7
Other Base Services	3168	3182	14	0.4
Morale, Welfare, and Recreation	502	557	55	11.0
Other Personnel Support	2544	2800	256	10.1
Bachelor Housing Operations	200	248	48	24.0
<u>Primary Workload Indicators:</u>				
Base Population	64437	65588	1151	1.8
Total Travel Transactions	76295	85683	9388	12.3
Supply Transactions	818579	1093539	274960	33.6
Total Vehicles	4089	3616	-473	-11.6
Total Population Supported	253447	175120	-78327	-30.9
Square Feet of Dorm Space (Thousands)	13536	14209	673	5.0
Military Population	42836	43747	911	2.1
Student Population	36584	38529	1945	5.3
Weighted Rations Served	847460	804388	-43072	-5.1
<u>Descriptive Indicators:</u>				
BOS Budget	472	502	30	6.4
Mission Population	50250	50250	0	0.0
Total Transactions Processed	1011220	1314454	303234	30.0
Requisitions	53654	68689	15035	28.0
Equipment Transactions	74797	91475	16678	22.2
Receipts	64190	60751	-3439	-5.4
Total Inventory Item Records	394925	468420	73495	18.6
Equipment Item Records	61133	71631	10498	17.2
Aviation Fuel Consumption	20141	15404	-4737	-23.5
Dorm Beds	61903	65062	3159	5.1

TABLE H11

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES USING

FY78 MODEL EQUATIONS: MISSION POPULATION SET AT FY77 LEVEL FOR SAC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	30225	28921	-1304	-4.3
Administration	7764	7056	-708	-9.1
Retail Supply Operations	8159	7904	-255	-3.1
Maintenance of Installation Equipment	2225	2179	-46	-2.1
Other Base Services	8049	7825	-223	-2.8
Morale, Welfare, and Recreation	967	904	-63	-6.5
Other Personnel Support	2723	2721	-2	-0.1
Bachelor Housing Operations	338	332	-6	-1.8
<u>Primary Workload Indicators:</u>				
Base Population	132803	131499	-1304	-1.0
Total Travel Transactions	109753	106887	2866	-2.6
Aviation Fuel Consumption	76682	79445	2763	3.6
Total Mileage (Millions)	681	880	189	27.4
Total Population Supported	344002	412907	68905	20.0
Square Feet of Dorm Space (Thousands)	10719	9401	-1318	-12.3
Military Population	111674	111774	100	0.1
Weighted Rations Served	398382	456386	58004	14.6
<u>Descriptive Indicators:</u>				
BOS Budget	890	883	-7	-0.8
Mission Population	102578	102578	0	0.0
Total Transactions	1959181	2846157	886976	45.3
Supply Transactions	1447490	2379694	932204	64.4
Requisitions	140200	142753	2553	1.8
Equipment Transactions	220092	193669	-26423	-12.0
Receipts	151399	130043	-21356	-14.1
Total Inventory Item Records	1079322	1085686	6364	0.6
Equipment Item Records	156036	162719	6683	4.3
Total Vehicles	15084	14599	-485	-3.2
Dorm Beds	48049	44860	-6189	-12.9

TABLE H12

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES USING
FY78 MODEL EQUATIONS: MISSION POPULATION SET AT FY77 LEVEL FOR TAC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	22255	18112	-4143	-18.6
Administration	5624	4878	-746	-13.3
Retail Supply Operations	6133	5053	-1080	-17.6
Maintenance of Installation Equipment	2183	1210	-973	-44.6
Other Base Services	5373	4316	-1057	-19.7
Morale, Welfare, and Recreation	666	617	-49	-7.4
Other Personnel Support	2055	1810	-245	-11.9
Bachelor Housing Operations	221	228	7	3.2
<u>Primary Workload Indicators:</u>				
Base Population	95635	91492	-4143	-4.3
Total Travel Transactions	88527	79330	-9197	-10.4
Total Transactions Processed	2496977	2764206	267229	10.7
Equipment Transactions	252252	206036	-46216	-18.3
Total Population Supported	256085	344345	88260	34.5
Square Feet of Dorm Space (Thousands)	7373	6524	-849	-11.5
Military Population	82202	78992	-3210	-3.9
Weighted Rations Served	305784	331951	26167	8.6
<u>Descriptive Indicators:</u>				
BOS Budget	526	539	13	2.5
Mission Population	73380	73380	0	0.0
Supply Transactions	1987474	2297505	310031	15.6
Requisitions	119406	146377	26971	22.6
Receipts	137845	114288	-23557	-17.1
Total Inventory Item Records	901803	890276	-11527	-1.3
Equipment Item Records	110864	111999	1135	1.0
Aviation Fuel Consumption	41937	40437	-1500	-3.6
Total Vehicles	11434	10737	-697	-6.1
Dorm Beds	33847	30444	-3403	-10.1

Procedure 4: Setting Mission Population and the Primary Workload Indicators at FY77 Levels

The next step in the model verification process involves entering the FY77 mission population changes (as was done for Tables H10 - H12) with the FY77 primary workload indicators. The model will then calculate values for the other indicators which, in turn, may be compared with the actual FY77 values. The results of doing this are presented in Tables H13 through H15.

Total population supported continues to show large differences between actual and predicted values across all three commands. However, the predicted values for the transaction indicators are much closer to the actual values because values for some transaction indicators are among the workload values being set for the model. In SAC, though, the predicted values for total transactions and supply transactions remain much different than the actual values.

The calculated values for manpower functions in SAC are reasonably similar to the actual values but ATC and TAC show considerable differences for these functions.

The model runs that calculated the predicted FY77 values for these tables are presented in Annex 4.

TABLE H13

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES USING
FY78 MODEL EQUATIONS: FY77 MISSION POPULATION ALLOCATED TO WORKLOAD INDICATORS

FOR ATC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	14187	14633	446	3.1
Administration	4148	4589	441	10.6
Retail Supply Operations	3103	2437	-666	-21.5
Maintenance of Installation Equipment	522	757	235	45.0
Other Base Services	3168	3156	-12	-0.4
Morale, Welfare, and Recreation	502	550	48	9.6
Other Personnel Support	2544	2903	359	14.1
Bachelor Housing Operations	200	241	41	20.5
<u>Primary Workload Indicators:</u>				
Base Population	64437	64883	446	0.7
Total Travel Transactions	76295	76295	0	0.0
Supply Transactions	818579	818578	-1	0.0
Total Vehicles	4089	4089	0	0.0
Total Population Supported	253447	173236	-80211	-31.7
Square Feet of Dorm Space (Thousands)	13536	13536	0	0.0
Military Population	42836	43277	441	1.0
Student Population	36584	36584	0	0.0
Weighted Rations Served	847460	847459	-1	0.0
<u>Descriptive Indicators:</u>				
BOS Budget	472	482	10	2.1
Mission Population	50250	50250	0	0.0
Total Transactions Processed	1011220	983746	-27474	-2.7
Requisitions	53654	51418	-2236	-4.2
Equipment Transactions	74797	68474	-6323	-8.5
Receipts	64190	45476	-18714	-29.2
Total Inventory Item Records	394925	335339	-59586	-15.1
Equipment Item Records	61133	51280	-9853	-16.1
Aviation Fuel Consumption	20141	12993	-7148	-35.5
Dorm Beds	61903	62033	130	0.2

TABLE H14

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES USING
FY78 MODEL EQUATIONS: FY77 MISSION POPULATION ALLOCATED TO WORKLOAD INDICATORS

FOR SAC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	30225	28608	-1617	-5.4
Administration	7764	7073	-691	-8.9
Retail Supply Operations	8159	7875	-284	-3.5
Maintenance of Installation Equipment	2225	2008	-217	-9.8
Other Base Services	8049	7814	-235	-2.9
Morale, Welfare, and Recreation	967	903	-64	-6.6
Other Personnel Support	2723	2604	-119	-4.4
Bachelor Housing Operations	338	332	-6	-1.8
<u>Primary Workload Indicators:</u>				
Base Population	132803	131186	-1617	-1.2
Total Travel Transactions	109753	109753	0	0.0
Aviation Fuel Consumption	76682	76682	0	0.0
Total Mileage (Millions)	681	681	0	0.0
Total Population Supported	344002	411923	67921	19.7
Square Feet of Dorm Space (Thousands)	10719	9389	-1330	-12.4
Military Population	111674	111508	-166	-0.2
Weighted Rations Served	398382	398383	1	0.0
<u>Descriptive Indicators:</u>				
BOS Budget	890	882	-8	0.9
Mission Population	102578	102578	0	0.0
Total Transactions	1959181	2842419	883238	45.1
Supply Transactions	1447490	2376568	929078	64.2
Requisitions	140290	142565	2365	1.7
Equipment Transactions	220092	193415	-26677	-12.1
Receipts	151399	129872	-21527	-14.2
Total Inventory Item Records	1079322	1084387	5065	0.5
Equipment Item Records	156036	162525	6489	4.2
Total Vehicles	15084	14601	-483	-3.2
Dorm Beds	48049	41814	-6235	-13.0

TABLE H15

COMPARISON OF PREDICTED FY77 VALUES WITH ACTUAL FY77 VALUES USING
FY78 MODEL EQUATIONS: FY77 MISSION POPULATION ALLOCATED TO WORKLOAD INDICATORS

FOR TAC

Variable Label	Actual FY77 Indicator Value	Predicted FY77 Indicator Value	Absolute Difference Actual-Predicted	Percent Difference Actual-Predicted
<u>Manpower:</u>				
Total BOS Manpower	22255	17869	-4386	-19.7
Administration	5624	4962	-662	-11.8
Retail Supply Operations	6133	4719	-1414	-23.1
Maintenance of Installation Equipment	2183	1255	-928	-42.5
Other Base Services	5373	4312	-1061	-19.8
Morale, Welfare, and Recreation	666	617	-49	-7.4
Other Personnel Support	2055	1751	-304	-14.8
Bachelor Housing Operations	221	254	33	14.9
<u>Primary Workload Indicators:</u>				
Base Population	95635	991250	-4385	-4.6
Total Travel Transactions	88527	88528	1	0.0
Total Transactions Processed	2496977	2497086	109	0.0
Equipment Transactions	252252	252259	7	0.0
Total Population Supported	256085	343432	87347	34.1
Square Feet of Dorm Space (Thousands)	7373	7373	0	0.0
Military Population	82202	78783	-3419	-4.2
Weighted Rations Served	305784	305768	-16	0.0
<u>Descriptive Indicators:</u>				
BOS Budget	526	548	22	4.2
Mission Population	73380	73380	0	0.0
Supply Transactions	1987474	2016092	28618	1.4
Requisitions	119406	128448	9042	7.6
Receipts	137845	100289	-37556	-27.3
Total Inventory Item Records	901803	806801	-95002	-10.5
Equipment Item Records	110864	101498	-9366	-8.5
Aviation Fuel Consumption	41937	30003	-11934	-28.5
Total Vehicles	11434	11347	-87	-0.8
Dorm Beds	33847	34475	628	1.9

**Procedure 5: Replacement of FY78 Values with Corresponding FY77 Values
and Setting Total BOS Manpower to the FY78 Level (Working
the Model Backwards)**

In order to further test the model, the values and equations for the FY78 manpower variables as well as the FY78 values for the workload variables were replaced with their corresponding FY77 values. In effect, the model was modified so as to produce FY77 values rather than FY78 values. Total BOS manpower was then set to the FY78 level and the model calculated FY78 values for the manpower, workload and descriptive indicators. The FY77 manpower equations that were used for this procedure are shown in Tables H16, H17, and H18. The results obtained from performing this procedure for each command are displayed in Tables H19 - H21.

For ATC, most of the predicted values were only slightly higher than the actual FY78 values except for, again, most of the transaction indicators as well as dorm beds, aviation fuel consumption, and many of the manpower functions. It should be noted, however, that the quality of data for these indicators is not as good as it might be.

SAC and TAC, on the other hand, generally have predicted values that are substantially below the actual FY78 values. The predicted manpower values for SAC, though, are generally very close to the actual values.

The model runs that produced the predicted FY78 values for these tables are displayed in Annex 5. The listings of the model data values and equations for these runs are presented in Annex 6.

TABLE H16
FY77 MANPOWER EQUATIONS FOR ATC

-660.3 = -ADM + .0456 (BASE POPULATION) + .0072 (TOTAL TRAVEL TRANSACTIONS)
-455.7 = -RSO + .00323 (TOTAL SUPPLY TRANSACTIONS)
25.9 = -MIE + .134 (TOTAL VEHICLES)
-1393.9 = -OBS + .0070 (TOTAL POPULATION SUPPORTED)
-142.5 = -MWR + .0060 (MILITARY POPULATION) + .0028 (STUDENT POPULATION)
-426.1 = -OPS + .0057 (TOTAL POPULATION SUPPORTED) + .0018 (WEIGHTED
RATIONS SERVED)
-132 = -BHO + .0050 (SQUARE FEET OF DORM SPACE)

TABLE H17
FY77 MANPOWER EQUATIONS FOR SAC

-201.9 = -ADM + .0500 (BASE POPULATION) + .0084 (TOTAL TRAVEL TRANSACTIONS)

-4419 = -RSO + .0037 (SUPPLY ITEM RECORDS) + .0106 (AVIATION FUEL
CONSUMPTION)

+494 = -MIE + .5157 (MILITARY VEHICLES) + .35 (TOTAL ANNUAL MILEAGE)

-3129.9 = -OBS + .0143 (TOTAL POPULATION SUPPORTED)

-598.5 = -MWR + .0033 (MILITARY POPULATION)

-1256.3 = -OPS + .0016 (TOTAL POPULATION SUPPORTED) + .0023 (WEIGHTED
RATIONS ADDED)

-286 = -BHO + .000466 (MILITARY POPULATION)

TABLE H18
FY77 MANPOWER EQUATIONS FOR TAC

-529.5 = -ADM + .0392 (BASE POPULATION)+ .0152 (TOTAL TRAVEL TRANS-
ACTIONS)

-1597 = -RSO + .00182 (TOTAL TRANSACTIONS PROCESSED)

-777.4 = -MIE + .00160 (TOTAL EQUIPMENT TRANSACTIONS) + 2.459 (AIRCRAFT
TRACTORS)

-2760.9 = -OBS + .0102 (TOTAL POPULATION SUPPORTED)

-460.5 = -MWR + .0025 (MILITARY POPULATION)

-471.8 = -OPS + .0026 (TOTAL POPULATION SUPPORTED) + .0030 (WEIGHTED
RATIONS SERVED)

-102 = -BHO + .0161 (SQUARE FEET OF DORM SPACE)

TABLE H19

COMPARISON OF PREDICTED FY78 VALUES WITH ACTUAL FY78 VALUES
 USING FY77 MANPOWER EQUATIONS: TOTAL BOS MANPOWER SET AT
 FY78 LEVEL FOR ATC

VARIABLE LABEL	ACTUAL FY78 INDICATOR VALUE	PREDICTED FY78 INDI- CATOR VALUE	ABSOLUTE DIFFERENCE ACTUAL - PREDICTED	PERCENT DIFFERENCE ACTUAL - PREDICTED
Total BOS Manpower	14816	14816	0	0.0
Administration	4607	4230	-377	-8.9
Retail Supply Operations	3027	3965	938	31.0
Maintenance of Installation Equip.	652	454	-198	-30.4
Other Base Services	3069	2607	-462	-15.1
Morale, Welfare & Recreation	542	509	-33	-6.1
Other Personnel Support	2678	2848	170	6.4
Bachelor Housing Operations	241	202	-39	-16.2
Base Population	62559	64897	2338	3.7
Total Travel Transactions	81949	84833	2884	3.5
Supply Transaction	1062509	1086460	23951	2.3
Total Vehicles	3472	3583	111	3.2
Total Population Supported	167011	173275	6264	3.8
Square Feet of Dorm Space (x 1000)	13554	14059	505	3.7
Military Population	41727	43286	1559	3.7
Student Population	36798	38133	1335	3.6
Weighted Rations Served	771771	796935	25164	3.3
BOS Budget	484	441	-43	-8.9
Transactions Audited	352628	318392	-34236	-9.7
Leave and Pay Accounts	82545	85632	3087	3.7
Civilian Pay Records	24112	25013	901	3.7
Material and Services Transactions	79791	66938	-12853	-16.1
Mission Population	47743	50081	2338	4.9
Total Transactions Processed	1277155	1305945	28790	2.3
Requisitions	66740	68245	1505	2.3
Equipment Transactions	88879	90883	2004	2.3
Receipts	59027	60358	1331	2.3
Total Inventory Item Records	453401	640994	187593	41.4
Supply Item Records	384415	542974	158559	41.3
Equipment Item Records	69334	98021	28687	41.4
Aviation Fuel Consumption	15132	18530	3398	22.5
Military Vehicles	1080	1115	35	3.2
Aircraft Tractors	40	41	1	2.5
Special Handling Vehicles	1040	1073	33	3.2
Non-Military Vehicles	2392	2469	77	3.2
General Purpose Automobiles	478	493	15	3.1
All Purpose Trucks	1914	1975	61	3.2
Dorm Beds	62114	45987	-16127	-26.0

TABLE H20

COMPARISON OF PREDICTED FY78 VALUES WITH ACTUAL FY78 VALUES
 USING FY77 MANPOWER EQUATIONS: TOTAL BOS MANPOWER SET AT
 FY78 LEVEL FOR SAC

VARIABLE LABEL	ACTUAL FY78 INDICATOR VALUE	PREDICTED FY78 INDI- CATOR VALUE	ABSOLUTE DIFFERENCE ACTUAL - PREDICTED	PERCENT DIFFERENCE ACTUAL - PREDICTED
Total BOS Manpower	28905	28905	0	0
Administration	7049	6709	-340	-4.8
Retail Supply Operations	7900	7753	-147	-1.9
Maintenance of Installation Equip.	2179	2063	-116	-5.3
Other Base Services	7822	8287	465	5.9
Morale, Welfare & Recreation	903	921	18	2.0
Other Personnel Support	2720	2840	120	4.4
Bachelor Housing Operations	332	332	0	0.0
Base Population	131322	114857	-16465	-12.5
Total Travel Transactions	106779	91032	-15747	-14.8
Supply Item Records	921863	817638	-104225	-11.3
Aviation Fuel Consumption	79346	70020	-9326	-11.8
Military Vehicles	4656	4384	-272	-5.8
Total Annual Mileage (Millions)	880	848	-32	-3.6
Total Population Supported	412551	360650	-51901	-12.6
Square Feet of Dorm Space (x 1000)	9395	8767	-628	-6.7
Military Population	111643	97628	-14015	-12.6
Weighted Rations Served	456186	437613	-18573	-4.1
BOS Budget	882	824	-58	-6.6
Transactions Audited	610702	547915	-62787	-10.3
Leave and Pay Accounts	130544	114176	-16368	-12.5
Civilian Pay Records	21510	18813	-2697	-12.5
Material and Services Transactions	126881	110888	-15993	-12.6
Mission Population	102417	85952	-16465	-16.1
Total Transactions	2842420	2489408	-353012	-12.4
Supply Transactions	2376568	2081413	-295155	-12.4
Requisitions	142565	124858	-17707	-12.4
Equipment Transactions	193415	169396	-24019	-12.4
Receipts	129872	113742	-16130	-12.4
Total Inventory Item Records	1042990	961787	-81203	-7.8
Equipment Item Records	121127	144150	23023	19.0
Total Vehicle Equivalents	32201	31260	-941	-2.9
Total Vehicles	14601	13748	-853	-5.8
Aircraft Tractors	321	302	-19	-5.9
Special Handling Vehicles	4335	4082	-253	-5.8
Non-Military Vehicles	9945	9364	-581	-5.8
General Purpose Automobiles	1221	1149	-72	-5.9
All Purpose Trucks	8724	8214	-510	-5.9
Dorm Beds	41837	39401	-2436	-5.8

TABLE H21
COMPARISON OF PREDICTED FY78 VALUES WITH ACTUAL FY78 VALUES
USING FY77 MANPOWER EQUATIONS: TOTAL BOS MANPOWER SET AT
FY78 LEVEL FOR TAC

VARIABLE LABEL	ACTUAL FY78 INDICATOR VALUE	PREDICTED FY78 INDI- CATOR VALUE	ABSOLUTE DIFFERENCE ACTUAL - PREDICTED	PERCENT DIFFERENCE ACTUAL - PREDICTED
Total BOS Manpower	18791	18791	0	0.0
Administration	5180	3760	-1420	-27.4
Retail Supply Operations	5208	5577	369	7.1
Maintenance of Installation Equip.	1236	1691	455	36.8
Other Base Services	4427	5105	678	15.3
Morale, Welfare, & Recreation	626	592	-34	-5.4
Other Personnel Support	1875	1885	10	0.5
Bachelor Housing Operations	239	180	-59	-24.7
Base Population	98039	61070	-36969	-37.7
Total Travel Transactions	84562	55023	-29539	-34.9
Total Transactions Processed	2888476	2186801	-701675	-24.3
Equipment Transactions	220525	138716	-81809	-37.1
Aircraft Tractors	404	281	-123	-30.5
Total Population Supported	368987	229847	-139140	-37.7
Square Feet of Dorm Space (x 1000)	6881	4867	-2014	-29.3
Military Population	84645	52727	-31918	-37.7
Weighted Rations Served	344877	271890	-72987	-21.2
BOS Budget	570	425	-145	-25.4
Transactions Audited	425233	330551	-94682	-22.3
Leave and Pay Accounts	99647	62071	-37576	-37.7
Civilian Pay Records	14978	9330	-5648	-37.7
Material & Services Transactions	87098	54604	-32494	-37.3
Mission Population	79248	42279	-36969	-46.7
Supply Transactions	2396100	1839396	-556704	-23.2
Requisitions	152659	117191	-35468	-23.2
Receipts	119192	91499	-27693	-23.2
Total Inventory Item Records	929105	1021350	92245	9.9
Supply Item Records	812221	892861	80640	9.9
Equipment Item Records	116884	128489	11605	9.9
Aviation Fuel Consumption	45291	56822	11531	25.5
Total Vehicles	11347	7902	-3445	-30.4
Military Vehicles	4482	3121	-1361	-30.4
Special Handling Equipment	4078	2840	-1238	-30.4
Non-Military Vehicles	6865	4781	-2084	-30.4
General Purpose Automobiles	736	513	-223	-30.3
All Purpose Trucks	6129	4268	-1861	-30.4
Dorm Beds	32138	22571	-9567	-29.8

Procedure 6: Calculation of FY78 Manpower by Substitution of FY78
Workload Values into FY77 Manpower Equations

This last procedure that was used to verify the model was to substitute FY78 workload values into the FY77 manpower equations in order to obtain calculated values of FY78 manpower. The results of this procedure are presented in Tables H22, H23, and H24.

As can be seen, the predicted values for many individual manpower functions show substantial variations from the actual manpower values across all three commands. The predicted total BOS manpower functions for ATC and SAC, however, vary only about 8% from the actual total BOS manpower. On the other hand, the predicted value for TAC is off by more than 30% from the actual value. This probably reflects the nearly 24% drop in actual BOS manpower for TAC from FY77 to FY78.

TABLE H22
 SUBSTITUTION OF FY78 WORKLOAD VALUES INTO FY77
 MANPOWER EQUATIONS FOR ATC

	<u>PREDICTED FY78 MANPOWER VALUE</u>	<u>ACTUAL FY78 MANPOWER VALUE</u>	<u>PERCENT DIFFERENCE</u>
ADMINISTRATION	4103.0	4607	-10.9
RETAIL SUPPLY OPERATIONS	3887.6	3027	28.4
MAINTENANCE OF INSTALLATION EQUIPMENT	439.3	652	-32.6
OTHER BASE SERVICES	2563.0	3069	-16.5
MORALE, WELFARE, AND RECREATION	495.9	542	-8.5
OTHER PERSONNEL SUPPORT	1915.1	2678	-28.5
BACHELOR HOUSING OPERATIONS	199.8	241	-17.1
TOTAL	13603.7	14816	-8.2

TABLE H23
 SUBSTITUTION OF FY78 WORKLOAD VALUES INTO FY77
 MANPOWER EQUATIONS FOR SAC

	<u>PREDICTED FY78 MANPOWER VALUE</u>	<u>ACTUAL FY78 MANPOWER VALUE</u>	<u>PERCENT DIFFERENCE</u>
ADMINISTRATION	7664.9	7049	8.7
RETAIL SUPPLY OPERATIONS	8182.4	7900	3.6
MAINTENANCE OF INSTALLATION EQUIPMENT	2215.1	2179	1.7
OTHER BASE SERVICES	9029.3	7822	15.4
MORALE, WELFARE, AND RECREATION	966.9	903	7.1
OTHER PERSONNEL SUPPORT	2965.6	2720	9.0
BACHELOR HOUSING OPERATIONS	331.6	332	-0.1
TOTAL	31355.8	28905	8.5

TABLE H24
SUBSTITUTION OF FY78 WORKLOAD VALUES INTO FY77
MANPOWER EQUATIONS FOR TAC

	<u>PREDICTED FY78 MANPOWER VALUE</u>	<u>ACTUAL FY78 MANPOWER VALUE</u>	<u>PERCENT DIFFERENCE</u>
ADMINISTRATION	5658.0	5180	9.2
RETAIL SUPPLY OPERATIONS	6854.0	5208	31.6
MAINTENANCE OF INSTALLATION EQUIPMENT	2123.7	1236	71.8
OTHER BASE SERVICES	6524.6	4427	47.4
MORALE, WELFARE, AND RECREATION	672.1	626	7.4
OTHER PERSONNEL SUPPORT	2645.8	1875	31.5
BACHELOR HOUSING OPERATIONS	212.8	239	-11.0
TOTAL	24691.0	18791	31.4

ANNEX 1

Model runs used to compute FY77 indicator values by setting total FY78 BOS manpower to the FY77 level (Tables H1, H2, and H3)

305PG

AIR FORCE BASE OPERATING SUPPORT AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

1

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

-629

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

0

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?

2

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

AIR TRAINING COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	4607.0	-199.8	4407.2	-4.34
RETAIL SUPPLY OPERATIONS	3027.0	-90.6	2936.4	-2.99
MAINTENANCE OF INSTALLATION EQUIPMENT	652.0	-29.5	622.5	-4.53
OTHER BASE SERVICES	3069.0	-135.3	2933.7	-4.41
MORALE WELFARE & RECREATION	542.0	-17.7	524.3	-3.27
OTHER PERSONNEL SUPPORT	2679.0	-147.4	2531.6	-5.71
BACHELOR HOUSING OPERATIONS	241.0	-8.6	232.4	-3.55
TOTAL	14816.0	-629.0	14187.0	-4.25

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	81949.0	-4484.3	77464.7	-5.5
BOS BUDGET	483.6	-22.6	461.0	-4.7
TRANSACTIONS AUDITED	352628.1	-18160.9	334467.5	-5.2
LEAVE AND PAY ACCOUNTS	82546.6	-4822.6	77724.0	-5.8
CIVILIAN PAY RECORDS	24112.1	-1408.7	22703.4	-5.8
MATERIAL & SERVICES TRANSACTIONS	79790.9	-6818.1	72972.8	-8.5
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	167011.0	-9737.0	157274.0	-5.8
BASE POPULATION	52559.0	-3654.9	58904.1	-5.8
BOS POPULATION	14816.0	-629.0	14187.0	-4.2
MILITARY POPULATION	41727.0	-2437.9	39289.1	-5.8
STUDENTS	36798.0	-2095.3	34702.7	-5.7
MISSION POPULATION	47743.0	-3025.9	44717.1	-6.3
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	1277155.0	-45012.1	1232142.9	-3.5
SUPPLY TRANSACTIONS	1062509.0	-37447.1	1025061.9	-3.5
REQUISITIONS	66740.0	-2352.2	64387.8	-3.5
EQUIPMENT TRANSACTIONS	88879.0	-3132.5	85746.6	-3.5
RECEIPTS	59027.0	-2080.3	56946.6	-3.5
TOTAL INVENTORY ITEM RECORDS	453401.0	-18124.0	435277.0	-4.0
SUPPLY ITEM RECORDS	384067.2	-15352.5	368714.7	-4.0
EQUIPMENT ITEM RECORDS	99333.6	-2771.5	96562.2	-4.0
AVIATION FUEL CONSUMPTION	15132.0	-328.3	14803.7	-2.2
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	3472.0	-173.7	3298.3	-5.0
MILITARY VEHICLES	1080.0	-54.0	1026.0	-5.0
AIRCRAFT TRACTORS	40.0	-2.0	38.0	-5.0
SPECIAL HANDLING	1040.0	-52.0	988.0	-5.0
NON-MILITARY VEHICLES	3392.0	-119.7	3272.3	-5.1
GENERAL PURPOSE AUTO	478.0	-23.9	454.1	-5.0
ALL PURPOSE TRUCKS	1914.0	-95.8	1818.2	-5.0

BACHELOR HOUSING INDICATORS:

50 FT DORM SPACE	13554.0	-792.9	12761.1	-5.9
DORM BEDS	62113.7	-3568.1	58545.6	-5.7

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED	771771.0	-39479.6	732291.4	-5.1
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ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP
ITERATION OPTION=

3

STOP RUN COMPLETE

SPU'S: 6.6

305FG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

2

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

1320

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

0

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?

2

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY-CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7049.0	481.8	7530.8	6.83
DETAIL SUPPLY OPERATIONS	7900.0	264.3	8164.3	3.35
MAINTENANCE OF INSTALLATION EQUIPMENT	2179.0	65.6	2244.6	3.01
OTHER BASE SERVICES	7822.0	415.6	8237.6	5.31
MORALE WELFARE & RECREATION	903.0	29.0	932.0	3.22
OTHER PERSONNEL SUPPORT	2720.0	59.1	2779.1	2.17
BACHELOR HOUSING OPERATIONS	332.0	4.1	336.1	1.24
TOTAL	28905.0	1320.0	30225.0	4.57

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE INDICATOR	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	106779.0	10424.5	117203.5	9.8
BOS BUDGET	882.1	38.7	920.8	4.2
TRANSACTIONS AUDITED	810701.6	41969.0	852670.5	6.9
LEAVE AND PAY ACCOUNTS	130544.0	10940.8	141484.9	8.4
CIVILIAN PAY RECORDS	21510.0	1802.7	23312.2	8.4
MATERIAL & SERVICES TRANSACTIONS	126881.2	10690.5	137571.7	8.4
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	412551.0	34358.9	446910.0	8.3
BASE POPULATION	131322.0	11006.0	142328.0	8.4
BOS POPULATION	28905.0	1320.0	30225.0	4.6
MILITARY POPULATION	111543.0	9335.8	120978.8	8.4
MISSION POPULATION	102417.0	9686.0	112103.0	9.5
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2842419.0	235870.2	3078289.1	8.3
SUPPLY TRANSACTIONS	2376566.0	197212.7	2573780.6	8.3
REQUISITIONS	142565.0	11831.3	154396.3	8.3
EQUIPMENT TRANSACTIONS	193415.0	16049.0	209464.0	8.3
RECEIPTS	129872.0	10777.3	140649.3	8.3
TOTAL INVENTORY ITEM RECORDS	1084387.4	81917.4	1166304.8	7.6
SUPPLY ITEM RECORDS	921363.0	69639.9	991002.9	7.6
EQUIPMENT ITEM RECORDS	162524.5	12277.5	174802.0	7.6
AVIATION FUEL CONSUMPTION	79346.0	6231.4	85577.4	7.9
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL MILEAGE	880.0	20.9	900.9	2.4
TOTAL VEHICLE EQUIVALENTS	33200.5	1252.7	34453.2	3.8
TOTAL VEHICLES	14601.2	550.9	15152.1	3.8
MILITARY VEHICLES	4656.0	175.7	4831.7	3.8
AIRCRAFT TRACTORS	320.8	12.1	332.9	3.8
SPECIAL HANDLING	4335.2	163.6	4498.8	3.8
NON-MILITARY VEHICLES	9945.2	375.2	10320.5	3.8
GENERAL PURPOSE AUTO	1220.8	36.1	1256.9	3.0
ALL PURPOSE TRUCKS	8724.4	329.2	9053.6	3.8

BACHELOR HOUSING INDICATORS:

50 FT DORM SPACE
DORM BEDS

9395.0	418.1	9813.1	4.5
-1837.0	1622.7	-3459.7	3.9

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED

456186.0	12415.0	468601.0	2.7
----------	---------	----------	-----

ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES,2=BEGIN NEW CYCLE,3=STOP
ITERATION OPTION=

3

STOP RUN COMPLETE

SFU'S:6.9

!

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

3

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

3464

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

0

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?

2

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

TACTICAL AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	5180.0	1509.2	6719.2	29.71
DETAIL SUPPLY OPERATIONS	5208.0	792.0	6000.0	15.21
MAINTENANCE OF INSTALLATION EQUIPMENT	1236.0	133.8	1369.8	10.82
OTHER BASE SERVICES	4427.0	565.4	4992.4	12.77
MORALE WELFARE & RECREATION	626.0	46.1	672.1	7.37
OTHER PERSONNEL SUPPORT	1875.0	333.4	2208.4	17.78
BACHELOR HOUSING OPERATIONS	239.0	54.2	293.2	22.67
TOTAL	18791.0	3464.0	22255.0	18.41

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE INDICATOR	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	84562.0	26672.0	111234.0	31.5
BOS BUDGET	569.9	157.0	726.9	27.5
TRANSACTIONS AUDITED	425233.1	102612.4	527845.5	24.1
LEAVE AND PAY ACCOUNTS	99646.8	33927.9	133574.7	34.0
CIVILIAN PAY RECORDS	14978.4	5099.9	20078.3	34.0
MATERIAL & SERVICES TRANSACTIONS	87098.4	35216.4	122314.8	40.4
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	368987.0	125633.3	494620.3	34.0
BASE POPULATION	98039.0	33380.4	131419.5	34.0
BOS POPULATION	18791.0	3464.0	22255.0	18.4
MILITARY POPULATION	84645.0	28820.0	113465.0	34.0
MISSION POPULATION	79248.0	29916.4	109164.4	37.8
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2888476.0	633560.8	3522036.8	21.9
SUPPLY TRANSACTIONS	2396100.0	502663.2	2898763.2	21.3
REQUISITIONS	152659.0	32025.4	184684.4	21.0
EQUIPMENT TRANSACTIONS	220525.0	73867.6	294392.6	33.5
RECEIPTS	119192.0	25004.6	144196.6	21.0
TOTAL INVENTORY ITEM RECORDS	929105.0	197992.8	1127097.8	21.3
SUPPLY ITEM RECORDS	812221.0	173084.7	985305.7	21.3
EQUIPMENT ITEM RECORDS	116884.0	24908.0	141792.1	21.3
AVIATION FUEL CONSUMPTION	45291.0	24749.1	70040.1	54.6
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	11347.0	3110.8	14457.8	27.4
MILITARY VEHICLES	4482.0	1228.7	5710.7	27.4
AIRCRAFT TRACTORS	404.0	110.8	514.8	27.4
SPECIAL HANDLING	4078.0	1118.0	5196.0	27.4
NON-MILITARY VEHICLES	6865.0	1882.0	8747.0	27.4
GENERAL PURPOSE AUTO	756.0	201.8	957.8	27.4
ALL PURPOSE TRUCKS	6129.0	1680.2	7809.3	27.4

BACHELOR HOUSING INDICATORS:

50 FT DORM SPACE

6881.0

1818.5

8699.5

26.4

DORM BEDS :

32138.0,

8638.2

40776.2

26.9

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED

344877.0

65902.3

410779.3

19.1

ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES,2=BEGIN NEW CYCLE,3=STOP

ITERATION OPTION=

3

STOP RUN COMPLETE

SFU'S:6.8

ANNEX 2

Model runs used to compute FY77 indicator values by setting total FY78 BOS manpower to the FY77 level and allocating the change to each manpower function (Tables H4, H5, and H6)

308PG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

1

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

-629

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

7

ENTER METHOD BY WHICH FUNCTION CHANGES WILL BE SPECIFIED AS FOLLOWS:

- 1=ABSOLUTE NUMBER OF PEOPLE
- 2=PERCENT OF FUNCTION MANPOWER
- 3=PERCENT OF 30S MANPOWER
- 4=PERCENT OF TOTAL CHANGE

METHOD:

1

ENTER FUNCTIONS AND ASSOCIATED CHANGES (ONE FUNCTION PER LINE)
USING THE FOLLOWING NUMBERS TO DENOTE FUNCTIONS:

- 1=ADMINISTRATION
- 2=RETAIL SUPPLY OPERATIONS
- 3=MAINTENANCE OF INSTALLATION EQUIPMENT
- 4=OTHER BASE SERVICES
- 5=MORALE WELFARE & RECREATION
- 6=OTHER PERSONNEL SUPPORT
- 7=BACHELOR HOUSING OPERATIONS

FUNCTION,CHANGE:

1,-459

FUNCTION,CHANGE:

2,76

FUNCTION,CHANGE:

3,-130

FUNCTION,CHANGE:

4,99

FUNCTION,CHANGE:

5,-40

FUNCTION,CHANGE:

6,-134

FUNCTION,CHANGE:

7,-21

13 THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?

2

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

AIP TRAINING COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	4607.0	-453.0	4148.0	-9.96
RETAIL SUPPLY OPERATIONS	3027.0	76.0	3103.0	2.51
MAINTENANCE OF INSTALLATION EQUIPMENT	652.0	-130.0	522.0	-19.94
OTHER BASE SERVICES	3069.0	99.0	3168.0	3.23
MORALE WELFARE & RECREATION	542.0	-40.0	502.0	-7.38
OTHER PERSONNEL SUPPORT	1678.0	-134.0	2544.0	-5.00
BACHELOR HOUSING OPERATIONS	241.0	-41.0	200.0	-17.01
TOTAL	14816.0	-629.0	14187.0	-4.25

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	499.12
RETAIL SUPPLY OPERATIONS	510.34
MAINTENANCE OF INSTALLATION EQUIPMENT	11.51
OTHER BASE SERVICES	748.86
MORALE WELFARE & RECREATION	45.00
OTHER PERSONNEL SUPPORT	572.51
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	81949.0	-21529.8	60419.2	-26.3
BOS BUDGET	483.6	-108.3	375.3	-22.4
TRANSACTIONS AUDITED	352628.4	-87102.9	265525.4	-24.7
LEAVE AND PAY ACCOUNTS	82546.6	-23115.3	59431.3	-28.0
CIVILIAN PAY RECORDS	24112.1	-6752.1	17360.1	-28.0
MATERIAL & SERVICES TRANSACTIONS	79790.9	-32700.7	47090.2	-41.0
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	167011.0	-46752.2	120258.8	-28.0
BASE POPULATION	62559.0	-17518.2	45040.8	-28.0
BOS POPULATION	14816.0	-629.0	14187.0	-4.2
MILITARY POPULATION	41727.0	-11684.8	30042.2	-28.0
STUDENTS	36798.0	-10031.3	26766.7	-27.3
MISSION POPULATION	47743.0	-16889.2	30853.8	-35.4
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	1277155.0	-215736.9	1061418.0	-16.9
SUPPLY TRANSACTIONS	1062509.0	-179479.0	883030.1	-16.9
REQUISITIONS	66740.0	-11273.7	55466.3	-16.9
EQUIPMENT TRANSACTIONS	88879.0	-15013.4	73865.6	-16.9
RECEIPTS	59027.0	-9970.8	49056.2	-16.9
TOTAL INVENTORY ITEM RECORDS	453401.0	-86867.5	366533.5	-19.2
SUPPLY ITEM RECORDS	384067.2	-73583.7	310483.5	-19.2
EQUIPMENT ITEM RECORDS	69333.8	-13283.8	56050.0	-19.2
AVIATION FUEL CONSUMPTION	15132.0	275.3	15407.3	1.8
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	3472.0	-833.0	2639.0	-24.0
MILITARY VEHICLES	1080.0	-259.1	820.9	-24.0
AIRCRAFT TRACTORS	40.0	-9.6	30.4	-24.0
SPECIAL HANDLING	1040.0	-249.5	790.5	-24.0
NON-MILITARY VEHICLES	2392.0	-573.9	1818.1	-24.0
GENERAL PURPOSE AUTO	478.0	-114.7	363.3	-24.0
ALL PURPOSE TRUCKS	1914.0	-459.2	1454.8	-24.0
BACHELOR HOUSING INDICATORS:				
50 FT DORM SPACE	13554.0	-3796.3	9757.7	-28.0
DORM BEDS	62113.7	-17083.3	45030.3	-27.5
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	771771.0	-189017.9	582753.1	-24.5

ENTER ITERATION OPTION AS FOLLOWS:
 1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP
 ITERATION OPTION=
 3
 TOP RUN COMPLETE
 00:06.5

30SPG

AIP FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

2

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

1320

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

7

ENTER METHOD BY WHICH FUNCTION CHANGES WILL BE SPECIFIED AS FOLLOWS:

- 1=ABSOLUTE NUMBER OF PEOPLE
- 2=PERCENT OF FUNCTION MANPOWER
- 3=PERCENT OF BOS MANPOWER
- 4=PERCENT OF TOTAL CHANGE

METHOD:

1

ENTER FUNCTIONS AND ASSOCIATED CHANGES (ONE FUNCTION PER LINE)

USING THE FOLLOWING NUMBERS TO DENOTE FUNCTIONS:

- 1=ADMINISTRATION
- 2=RETAIL SUPPLY OPERATIONS
- 3=MAINTENANCE OF INSTALLATION EQUIPMENT
- 4=OTHER BASE SERVICES
- 5=MORALE WELFARE & RECREATION
- 6=OTHER PERSONNEL SUPPORT
- 7=BACHELOR HOUSING OPERATIONS

FUNCTION, CHANGE:

1,715

FUNCTION, CHANGE:

2,259

FUNCTION, CHANGE:

3,46

FUNCTION, CHANGE:

4,227

FUNCTION, CHANGE:

5,64

FUNCTION, CHANGE:

6,0

FUNCTION, CHANGE:

7,0

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?
2

ENTER PRINT OPTION AS FOLLOWS:
1=DISPLAY MILITARY/CIVILIAN BREAKOUT
2=DISPLAY TOTAL MANPOWER ONLY

PPINT OPTION IS:
2

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7049.0	715.0	7764.0	10.14
RETAIL SUPPLY OPERATIONS	7900.0	259.0	8159.0	3.28
MAINTENANCE OF INSTALLATION EQUIPMENT	2179.0	46.0	2225.0	2.11
OTHER BASE SERVICES	7822.0	227.0	8049.0	2.90
MORALE WELFARE & RECREATION	903.0	64.0	967.0	7.09
OTHER PERSONNEL SUPPORT	2720.0	3.0	2723.0	.11
BACHELOR HOUSING OPERATIONS	332.0	6.0	338.0	1.81
TOTAL	28905.0	1320.0	30225.0	4.57

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	689.08
RETAIL SUPPLY OPERATIONS	244.22
MAINTENANCE OF INSTALLATION EQUIPMENT	43.59
OTHER BASE SERVICES	202.48
MORALE WELFARE & RECEPTION	12.17
OTHER PERSONNEL SUPPORT	0
BACHELOR HOUSING OPERATIONS	0.77

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE INDICATOR	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	106779.0	517.8	107296.8	.5
BOS BUDGET	882.1	2.1	884.2	.2
TRANSACTIONS AUDITED	610701.6	2315.5	613017.0	.4
LEAVE AND PAY ACCOUNTS	130544.0	603.6	131147.7	.4
CIVILIAN PAY RECORDS	21510.0	99.5	21609.5	.5
MATERIAL & SERVICES TRANSACTIONS	126881.2	589.8	127471.0	.5
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED(INCL DEP)	412551.0	1706.7	414257.7	.4
BOS POPULATION	131322.0	607.2	131929.2	.5
BOS POPULATION	28905.0	1320.0	30225.0	4.6
MILITARY POPULATION	111643.0	496.8	112139.8	.4
MISSION POPULATION	102417.0	-712.8	101704.2	-.7
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2842419.0	12958.6	2855377.5	.5
SUPPLY TRANSACTIONS	2376568.0	10834.7	2387402.7	.5
REQUISITIONS	142565.0	650.0	143215.0	.5
EQUIPMENT TRANSACTIONS	193415.0	881.7	194296.7	.5
RECEIPTS	129872.0	592.1	130464.1	.5
TOTAL INVENTORY ITEM RECORDS	1084387.4	4500.5	1088887.9	.4
SUPPLY ITEM RECORDS	921063.0	3826.0	925889.0	.4
EQUIPMENT ITEM RECORDS	162524.5	674.5	163199.0	.4
AVIATION FUEL CONSUMPTION	79346.0	342.4	79688.4	.4
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL MILEAGE	880.0	.7	880.7	.1
TOTAL VEHICLE EQUIVALENTS	33200.5	43.8	33244.3	.1
TOTAL VEHICLES	14601.2	19.2	14620.5	.1
MILITARY VEHICLES	4656.0	6.1	4662.1	.1
HIPOCRAFT TRACTORS	320.8	.4	321.2	.1
SPECIAL HANDLING	4335.2	5.7	4340.9	.1
NON-MILITARY VEHICLES	9945.2	13.1	9958.3	.1
GENERAL PURPOSE AUTO	1220.8	1.6	1222.4	.1
ALL PURPOSE TRUCKS	8724.4	11.5	8735.9	.1
BACHELOR HOUSING INDICATORS:				
SQ FT DORM SPACE	9395.0	22.3	9417.3	.2
DORM BEDS	41837.0	86.4	41923.4	.2
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	456186.0	495.1	456681.1	.1

ENTER ITERATION OPTION AS FOLLOWS:
 1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP
 ITERATION OPTION=
 3
 STOP RUN COMPLETE
 SFU'S: 7.1

BOSPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

3

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

3464

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

7

ENTER METHOD BY WHICH FUNCTION CHANGES WILL BE SPECIFIED AS FOLLOWS:

- 1=ABSOLUTE NUMBER OF PEOPLE
- 2=PERCENT OF FUNCTION MANPOWER
- 3=PERCENT OF BOS MANPOWER
- 4=PERCENT OF TOTAL CHANGE

METHOD:

1

ENTER FUNCTIONS AND ASSOCIATED CHANGES (ONE FUNCTION PER LINE)
USING THE FOLLOWING NUMBERS TO DENOTE FUNCTIONS:

- 1=ADMINISTRATION
- 2=RETAIL SUPPLY OPERATIONS
- 3=MAINTENANCE OF INSTALLATION EQUIPMENT
- 4=OTHER BASE SERVICES
- 5=MORALE WELFARE & RECREATION
- 6=OTHER PERSONNEL SUPPORT
- 7=BACHELOR HOUSING OPERATIONS

FUNCTION, CHANGE:

1,444

FUNCTION, CHANGE:

2,325

FUNCTION, CHANGE:

3,947

FUNCTION, CHANGE:

4,346

FUNCTION, CHANGE:

5,440

FUNCTION, CHANGE:

6,180

FUNCTION, CHANGE:

7,-18

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?

2

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

TACTICAL AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	5180.0	444.0	5624.0	8.57
RETAIL SUPPLY OPERATIONS	5208.0	925.0	6133.0	17.76
MAINTENANCE OF INSTALLATION EQUIPMENT	1236.0	947.0	2183.0	76.62
OTHER BASE SERVICES	4427.0	946.0	5373.0	21.37
MORALE WELFARE & RECREATION	626.0	40.0	666.0	6.39
OTHER PERSONNEL SUPPORT	1875.0	180.0	2055.0	9.60
BACHELOR HOUSING OPERATIONS	239.0	-18.0	221.0	-7.53
TOTAL	18791.0	3464.0	22255.0	18.43

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	955.24
RETAIL SUPPLY OPERATIONS	1188.03
MAINTENANCE OF INSTALLATION EQUIPMENT	991.43
OTHER BASE SERVICES	1133.78
MORALE WELFARE & RECREATION	55.32
OTHER PERSONNEL SUPPORT	290.75
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	84562.0	-8859.0	75703.0	-10.5
BOS BUDGET	569.9	-52.1	517.7	-9.2
TRANSACTIONS AUDITED	425233.1	-34082.5	391150.5	-8.0
LEAVE AND PAY ACCOUNTS	99646.8	-11269.1	88377.7	-11.3
CIVILIAN PAY RECORDS	14978.4	-1693.9	13284.5	-11.3
MATERIAL & SERVICES TRANSACTIONS	87098.4	-11697.1	75401.3	-13.4
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED(INCL DEP)	368987.0	-41728.9	327258.1	-11.3
BASE POPULATION	98039.0	-11087.3	86951.7	-11.3
SOS POPULATION	18791.0	3464.0	22255.0	18.4
MILITARY POPULATION	84645.0	-9572.5	75072.5	-11.3
MISSION POPULATION	79248.0	-14551.3	64696.7	-18.4
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2888476.0	-210436.5	2678039.5	-7.3
SUPPLY TRANSACTIONS	2396180.0	-166959.0	2229141.0	-7.0
PEQUISITIONS	152659.0	-10637.2	142021.8	-7.0
EQUIPMENT TRANSACTIONS	220525.0	-24535.0	195990.0	-11.1
RECEIPTS	119132.0	-8305.2	110826.8	-7.0
TOTAL INVENTORY ITEM RECORDS	929185.0	-65756.4	863428.6	-7.1
SUPPLY ITEM RECORDS	812221.0	-57484.1	754736.9	-7.1
EQUIPMENT ITEM RECORDS	116884.0	-8272.3	108611.7	-7.1
AVIATION FUEL CONSUMPTION	45291.0	-8219.6	37071.4	-18.1
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	11347.0	-1033.2	10313.8	-9.1
MILITARY VEHICLES	4482.0	-408.1	4073.9	-9.1
AIRCRAFT TRACTORS	404.0	-36.8	367.2	-9.1
SPECIAL HANDLING	4078.0	-371.3	3706.7	-9.1
NON-MILITARY VEHICLES	6865.0	-625.1	6239.9	-9.1
GENERAL PURPOSE AUTO	736.0	-67.0	669.0	-9.1
ALL PURPOSE TRUCKS	6129.0	-558.1	5570.9	-9.1
BACHELOR HOUSING INDICATORS:				
90 FT DORM SPACE	6881.0	-604.0	6277.0	-8.8
DORM BEDS	32138.0	-2869.1	29268.9	-8.9
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	344877.0	-21889.3	322987.7	-6.3

ENTER ITERATION OPTION AS FOLLOWS:
1=ACCUMULATE CHANGES,2=BEGIN NEW CYCLE,3=STOP
ITERATION OPTION=

3
STOP RUN COMPLETE
SPU'S:7.4

ANNEX 3

Model runs used to compute FY77 indicator values by setting the FY78 mission population alone to the FY77 level (Tables H10, H11, and H12)

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

1

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

2

ENTER CHANGE IN MISSION POPULATION (OR ZERO TO RETAIN CURRENT VALUE):

2507

ENTER THE NUMBER OF WORKLOAD INDICATORS FOR WHICH CHANGES WILL BE SPECIFIED:

0

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

AIR TRAINING COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	4607.0	165.9	4772.9	3.80
RETAIL SUPPLY OPERATIONS	3027.0	75.1	3102.1	2.48
MAINTENANCE OF INSTALLATION EQUIPMENT	652.0	24.5	676.5	3.76
OTHER BASE SERVICES	3069.0	112.7	3181.7	3.67
MORALE WELFARE & RECREATION	542.0	14.7	556.7	2.71
OTHER PERSONNEL SUPPORT	2670.0	122.1	2800.1	4.56
BACHELOR HOUSING OPERATIONS	241.0	7.1	248.1	2.94
TOTAL	14816.0	522.0	15338.0	3.52

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE INDICATOR	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	81949.0	3733.8	85682.8	4.6
BOS BUDGET	483.6	18.7	502.3	3.9
TRANSACTIONS AUDITED	352628.4	15078.0	367706.4	4.3
LEAVE AND PAY ACCOUNTS	82546.6	3996.8	86543.4	4.8
CIVILIAN PAY RECORDS	24112.1	1167.5	25279.6	4.8
MATERIAL & SERVICES TRANSACTIONS	79790.9	5660.7	85451.6	7.1
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	167011.0	8109.1	175120.1	4.9
BASE POPULATION	62559.0	3029.0	65588.0	4.8
BOS POPULATION	14816.0	522.0	15338.0	3.5
MILITARY POPULATION	41727.0	2020.2	43747.2	4.8
STUDENTS	36798.0	1730.9	38528.9	4.7
MISSION POPULATION	47743.0	2507.0	50250.0	5.3
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	1277155.0	37299.1	1314454.0	2.9
SUPPLY TRANSACTIONS	1062509.0	31030.4	1093539.4	2.9
REQUISITIONS	66740.0	1949.1	68689.1	2.9
EQUIPMENT TRANSACTIONS	88879.0	2595.7	91474.7	2.9
RECEIPTS	59027.0	1723.9	60750.9	2.9
TOTAL INVENTORY ITEM RECORDS	453401.0	15019.1	468420.1	3.3
SUPPLY ITEM RECORDS	384067.2	12722.3	396789.5	3.3
EQUIPMENT ITEM RECORDS	69333.8	2296.7	71630.5	3.3
AVIATION FUEL CONSUMPTION	15132.0	272.1	15404.1	1.8
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	3472.0	144.2	3616.2	4.2
MILITARY VEHICLES	1080.0	44.8	1124.8	4.2
AIRCRAFT TRACTORS	40.0	1.7	41.7	4.2
SPECIAL HANDLING	1040.0	43.2	1083.2	4.2
NON-MILITARY VEHICLES	2392.0	99.3	2491.3	4.2
GENERAL PURPOSE AUTO	478.0	19.8	497.8	4.2
ALL PURPOSE TRUCKS	1914.0	79.5	1993.5	4.2

BACHELOR HOUSING INDICATORS:

SQ FT DORM SPACE	13554.0	655.1	14209.1	4.2
DORM BEDS	62113.7	2947.3	65061.6	4.7

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED	771771.0	32617.1	804388.1	4.2
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ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP

ITERATION OPTION=

3

STOP RUN COMPLETE

SPU'S: 5.8

EOSPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

2

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

2

ENTER CHANGE IN MISSION POPULATION (OR ZERO TO RETAIN CURRENT VALUE):

161

ENTER THE NUMBER OF WORKLOAD INDICATORS FOR WHICH CHANGES WILL BE SPECIFIED:

0

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7049.0	7.1	7056.1	.10
RETAIL SUPPLY OPERATIONS	7900.0	3.3	7903.3	.05
MAINTENANCE OF INSTALLATION EQUIPMENT	2179.0	-1.2	2177.8	-.01
OTHER BASE SERVICES	7822.0	4.2	7826.2	.05
MORALE WELFARE & RECREATION	903.0	.5	903.5	.05
OTHER PERSONNEL SUPPORT	2720.0	.7	2720.7	.02
BACHELOR HOUSING OPERATIONS	932.0	.1	932.1	.02
TOTAL	28905.0	16.1	28921.1	.06

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	106779.0	108.0	106887.0	.1
BOS BUDGET	882.1	.6	882.7	.1
TRANSACTIONS AUDITED	610701.6	675.3	611376.9	.1
LEAVE AND PAY ACCOUNTS	130544.0	176.0	130720.1	.1
CIVILIAN PAY RECORDS	21510.0	29.0	21539.0	.1
MATERIAL & SERVICES TRANSACTIONS	126881.2	172.0	127053.2	.1
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	412551.0	356.2	412907.2	.1
BASE POPULATION	131322.0	177.1	131499.1	.1
BOS POPULATION	28905.0	16.1	28921.1	.1
MILITARY POPULATION	111643.0	131.2	111774.2	.1
MISSION POPULATION	102417.0	161.0	102578.0	.2
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2842419.0	3738.4	2846157.4	.1
SUPPLY TRANSACTIONS	2376568.0	3125.7	2379693.7	.1
PEQUISITIONS	142565.0	187.5	142752.5	.1
EQUIPMENT TRANSACTIONS	193415.0	254.4	193669.4	.1
PECEIPTS	129872.0	170.8	130042.8	.1
TOTAL INVENTORY ITEM RECORDS	1084387.4	1298.4	1085685.8	.1
SUPPLY ITEM RECORDS	921863.0	1103.8	922966.8	.1
EQUIPMENT ITEM RECORDS	162524.5	194.6	162719.0	.1
AVIATION FUEL CONSUMPTION	79346.0	98.8	79444.8	.1
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL MILEAGE	880.0	-1.1	878.9	-.0
TOTAL VEHICLE EQUIVALENTS	33200.5	-6.2	33194.3	-.0
TOTAL VEHICLES	14601.2	-2.7	14598.5	-.0
MILITARY VEHICLES	4656.0	-1.9	4654.1	-.0
AIRCRAFT TRACTORS	320.8	-1.1	320.7	-.0
SPECIAL HANDLING	4335.2	-1.0	4334.2	-.0
NON-MILITARY VEHICLES	9945.2	-1.9	9943.3	-.0
GENERAL PURPOSE AUTO	1220.8	-1.2	1219.6	-.0
ALL PURPOSE TRUCKS	8724.4	-1.6	8722.8	-.0

BACHELOR HOUSING INDICATORS:				
SQ FT DORM SPACE	9395.0	5.9	9400.9	.1
DORM BEDS	41837.0	22.8	41859.8	.1
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	456186.0	200.0	456386.0	.0

ENTER ITERATION OPTION AS FOLLOWS:
 1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP
 ITERATION OPTION=
 3
 STOP RUN COMPLETE
 SPL'S: 6.2
 !

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

3

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

2

ENTER CHANGE IN MISSION POPULATION (OR ZERO TO RETAIN CURRENT VALUE):

-5868

ENTER THE NUMBER OF WORKLOAD INDICATORS FOR WHICH CHANGES WILL BE SPECIFIED:

0

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

TACTICAL AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	5180.0	-301.9	4878.1	-5.83
RETAIL SUPPLY OPERATIONS	5208.0	-155.3	5052.7	-2.98
MAINTENANCE OF INSTALLATION EQUIPMENT	1236.0	-26.2	1209.8	-2.12
OTHER BASE SERVICES	4427.0	-110.9	4316.1	-2.50
MORALE WELFARE & RECREATION	626.0	-9.0	617.0	-1.44
OTHER PERSONNEL SUPPORT	1875.0	-65.4	1809.6	-3.49
BACHELOR HOUSING OPERATIONS	239.0	-10.6	228.4	-4.45
TOTAL	18791.0	-679.4	18111.6	-3.62

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
DETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	84562.0	-5231.6	79330.4	-6.2
BOS BUDGET	589.9	-30.8	559.1	-5.4
TRANSACTIONS AUDITED	425233.1	-20126.9	405106.1	-4.7
LEAVE AND PAY ACCOUNTS	99646.8	-6654.8	92992.0	-6.7
CIVILIAN PAY RECORDS	14978.4	-1000.3	13978.1	-6.7
MATERIAL & SERVICES TRANSACTIONS	87098.4	-6907.5	80190.9	-7.9
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	368987.0	-24642.3	344344.7	-6.7
BASE POPULATION	98039.0	-6547.4	91491.6	-6.7
BOS POPULATION	18791.0	-679.4	18111.6	-3.6
MILITARY POPULATION	84645.0	-5652.9	78992.1	-6.7
MISSION POPULATION	79248.0	-5868.0	73380.0	-7.4
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2888476.0	-124270.2	2764205.8	-4.3
SUPPLY TRANSACTIONS	2396100.0	-98595.2	2297504.8	-4.1
REQUISITIONS	152659.0	-6281.6	146377.4	-4.1
EQUIPMENT TRANSACTIONS	220525.0	-14488.8	206036.2	-6.6
RECEIPTS	119192.0	-4904.5	114287.5	-4.1
TOTAL INVENTORY ITEM RECORDS	929105.0	-38829.5	890275.5	-4.2
SUPPLY ITEM RECORDS	812221.0	-33944.6	778276.4	-4.2
EQUIPMENT ITEM RECORDS	116884.0	-4884.9	111999.2	-4.2
AVIATION FUEL CONSUMPTION	45291.0	-4850.7	40437.3	-10.7
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	11347.0	-610.2	10736.8	-5.4
MILITARY VEHICLES	4482.0	-241.0	4241.0	-5.4
AIRCRAFT TRACTORS	404.0	-21.7	382.3	-5.4
SPECIAL HANDLING	4078.0	-219.3	3858.7	-5.4
NON-MILITARY VEHICLES	6865.0	-369.2	6495.8	-5.4
GENERAL PURPOSE AUTO	736.0	-39.6	696.4	-5.4
ALL PURPOSE TRUCKS	6129.0	-329.6	5799.4	-5.4

BACHELOR HOUSING INDICATORS:

30 FT DORM SPACE
DORM BEDS

6881.0	-356.7	6524.3	-5.2
32138.0	-1694.3	30443.7	-5.3

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED

344877.6	-12926.4	331950.6	-3.7
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ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES,2=BEGIN NEW CYCLE,3=STOP

ITERATION OPTION=

3

STOP RUN COMPLETE

CPU'S:6.0

1

ANNEX 4

Model runs used to compute FY77 indicator values by setting FY78 mission population to the FY77 level and distributing those changes across the workload indicators (Tables H13, H14, and H15)

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

1

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

2

ENTER CHANGE IN MISSION POPULATION (OR ZERO TO RETAIN CURRENT VALUE):

2507

ENTER THE NUMBER OF WORKLOAD INDICATORS FOR WHICH CHANGES WILL BE SPECIFIED:

6

ENTER WORKLOAD INDICATOR AND ASSOCIATED PERCENT CHANGES (ONE INDICATOR
PER LINE) USING THE FOLLOWING NUMBERS TO DENOTE WORKLOAD INDICATORS:

1=TRAVEL TRANSACTIONS

2=SUPPLY TRANSACTIONS

3=TOTAL VEHICLES

4=SQ FT DORM SPACE

5=STUDENTS

6=WEIGHTED RATINGS SERVED

WORKLOAD INDICATOR CHANGE:

1=-6.399

WORKLOAD INDICATOR CHANGE:

2=-22.958

WORKLOAD INDICATOR CHANGE:

3=17.771

WORKLOAD INDICATOR CHANGE:

4=-.1328

WORKLOAD INDICATOR CHANGE:

5=-.5816

WORKLOAD INDICATOR CHANGE:

6=9.807

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

AIR TRAINING COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	4607.0	-17.6	4589.4	-0.38
RETAIL SUPPLY OPERATIONS	3027.0	-590.3	2436.7	-19.50
MAINTENANCE OF INSTALLATION EQUIPMENT	652.0	104.9	756.9	16.09
OTHER BASE SERVICES	3069.0	86.5	3155.5	2.82
MORALE WELFARE & RECREATION	542.0	7.7	549.7	1.42
OTHER PERSONNEL SUPPORT	2678.0	225.4	2903.4	8.42
BACHELOR HOUSING OPERATIONS	241.0	-2	240.8	-0.08
TOTAL	14816.0	-183.5	14632.5	-1.24

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	81949.0	-5653.7	76295.3	-6.9
BOS BUDGET	483.6	-2.0	481.6	-0.4
TRANSACTIONS AUDITED	352628.4	-1538.0	351090.4	-0.4
LEAVE AND PAY ACCOUNTS	82546.6	3065.8	85612.4	3.7
CIVILIAN PAY RECORDS	24112.1	895.5	25007.6	3.7
MATERIAL & SERVICES TRANSACTIONS	79790.9	-599.9	79191.0	-0.7

POPULATION INDICATORS:

TOTAL POPULATION SUPPORTED (INCL DEP)	167011.0	6225.2	173236.2	3.7
BASE POPULATION	62559.0	2323.5	64882.5	3.7
30S POPULATION	14816.0	-183.5	14632.5	-1.2
MILITARY POPULATION	41727.0	1549.6	43276.6	3.7
STUDENTS	36798.0	-214.0	36584.0	-0.6
MISSION POPULATION	47743.0	2507.0	50250.0	5.2

SUPPLY INDICATORS:

TOTAL TRANSACTIONS	-1277155.0	-293209.2	983945.7	-23.1
SUPPLY TRANSACTIONS	-1062509.0	-243930.8	818578.2	-23.1
REQUISITIONS	66740.0	-15322.2	51417.8	-23.1
EQUIPMENT TRANSACTIONS	88879.0	-20404.8	68474.2	-23.1
RECEIPTS	59027.0	-13551.4	45475.6	-23.1
TOTAL INVENTORY ITEM RECORDS	453401.0	-118062.2	335338.8	-26.1
SUPPLY ITEM RECORDS	384067.2	-100008.1	284059.1	-26.1
EQUIPMENT ITEM RECORDS	69333.8	-18054.1	51279.7	-26.1
AVIATION FUEL CONSUMPTION	15132.0	-2138.6	12993.4	-14.1

MAINT OF INSTA EQUIP INDICATORS:

TOTAL VEHICLES	3472.0	617.0	4089.0	17.1
MILITARY VEHICLES	1080.0	191.9	1271.9	17.1
AIRCRAFT TRACTORS	40.0	7.1	47.1	17.1
SPECIAL HANDLING	1040.0	184.8	1224.8	17.1
NON-MILITARY VEHICLES	2392.0	425.1	2817.1	17.1
GENERAL PURPOSE AUTO	478.0	84.9	562.9	17.1
ALL PURPOSE TRUCKS	1914.0	340.1	2254.1	17.1

ZACHELOR HOUSING INDICATORS:

SQ FT DORM SPACE	13554.0	-18.0	13536.0	-0.1
DORM BEDS	62113.7	-81.0	62032.7	-0.1

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED	771771.0	75687.6	847458.6	9.1
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ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP

ITERATION OPTION=

3

STOP RUN COMPLETE

SPU1:5.4

1

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

2

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

2

ENTER CHANGE IN MISSION POPULATION (OR ZERO TO RETAIN CURRENT VALUE):

161

ENTER THE NUMBER OF WORKLOAD INDICATORS FOR WHICH CHANGES WILL BE SPECIFIED:

6

ENTER WORKLOAD INDICATOR AND ASSOCIATED PERCENT CHANGES (ONE INDICATOR
PER LINE) USING THE FOLLOWING NUMBERS TO DENOTE WORKLOAD INDICATORS:

- 1=TRAVEL TRANSACTIONS
- 2=TOTAL ITEM RECORDS
- 3=AVIATION FUEL CONSUMPTION
- 4=MILITARY VEHICLE INVENTORY
- 5=TOTAL MILEAGE
- 6=WEIGHTED RATINGS SERVED

WORKLOAD INDICATOR CHANGE:

1,2.7852

WORKLOAD INDICATOR CHANGE:

3,-3.3574

WORKLOAD INDICATOR CHANGE:

5,-22.614

WORKLOAD INDICATOR CHANGE:

6,-12.671

ENTER PRINT OPTION AS FOLLOWS:

- 1=DISPLAY MILITARY/CIVILIAN BREAKOUT
- 2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7049.0	23.7	7072.7	.34
DETAIL SUPPLY OPERATIONS	7900.0	-25.3	7874.7	-.32
MAINTENANCE OF INSTALLATION EQUIPMENT	2179.0	-171.3	2007.7	-7.86
OTHER BASE SERVICES	7822.0	-7.7	7814.3	-.10
MORALE WELFARE & RECREATION	903.0	-.3	902.7	-.04
OTHER PERSONNEL SUPPORT	2720.0	-116.3	2603.7	-4.28
BACHELOR HOUSING OPERATIONS	332.0	-.0	332.0	-.01
TOTAL	28905.0	-297.3	28607.7	-1.03

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
DETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	106779.0	2974.0	109753.0	2.8
BOS BUDGET	882.1	-.5	881.6	-.1
TRANSACTIONS AUDITED	610701.6	-519.9	610181.6	-.1
LEAVE AND PAY ACCOUNTS	130544.0	-135.5	130408.5	-.1
CIVILIAN PAY RECORDS	21510.0	-22.3	21487.7	-.1
MATERIAL & SERVICES TRANSACTIONS	126881.2	-132.4	126748.8	-.1

POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	412551.0	-628.1	411923.0	-0.2
BASE POPULATION	131322.0	-136.4	131185.7	-0.1
30S POPULATION	28905.0	-297.3	28607.7	-1.0
MILITARY POPULATION	111643.0	-135.2	111507.8	-0.1
MISSION POPULATION	102417.0	161.0	102578.0	0.2
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2842419.0	0.	2842419.0	0.
SUPPLY TRANSACTIONS	2376568.0	0.	2376568.0	0.
REQUISITIONS	142565.0	0.	142565.0	0.
EQUIPMENT TRANSACTIONS	193415.0	0.	193415.0	0.
RECEIPTS	129872.0	0.	129872.0	0.
TOTAL INVENTORY ITEM RECORDS	1084387.4	0.	1084387.4	0.
SUPPLY ITEM RECORDS	921863.0	0.	921863.0	0.
EQUIPMENT ITEM RECORDS	162524.5	0.	162524.5	0.
AVIATION FUEL CONSUMPTION	79346.0	-2664.0	76682.0	-3.4
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL MILEAGE	880.0	-199.0	681.0	-22.6
TOTAL VEHICLE EQUIVALENTS	33200.5	0.	33200.5	0.
TOTAL VEHICLES	14601.2	0.	14601.2	0.
MILITARY VEHICLES	4656.0	0.	4656.0	0.
AIRCRAFT TRACTORS	320.8	0.	320.8	0.
SPECIAL HANDLING	4335.2	0.	4335.2	0.
NON-MILITARY VEHICLES	9945.2	0.	9945.2	0.
GENERAL PURPOSE AUTO	1220.8	0.	1220.8	0.
ALL PURPOSE TRUCKS	8724.4	0.	8724.4	0.
BACHELOR HOUSING INDICATORS:				
SQ FT DORM SPACE	9395.0	-6.1	9388.9	-0.1
DORM BEDS	41837.0	-23.5	41813.5	-0.1
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	456186.0	-57803.3	398382.7	-12.7

ENTER ITERATION OPTION AS FOLLOWS:
1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP
ITERATION OPTION=

3

STOP RUN COMPLETE

RESULTS:

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

3

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

2

ENTER CHANGE IN MISSION POPULATION (OR ZERO TO RETAIN CURRENT VALUE):

-5868

ENTER THE NUMBER OF WORKLOAD INDICATORS FOR WHICH CHANGES WILL BE SPECIFIED:

6

ENTER WORKLOAD INDICATOR AND ASSOCIATED PERCENT CHANGES (ONE INDICATOR
PER LINE) USING THE FOLLOWING NUMBERS TO DENOTE WORKLOAD INDICATORS:

1=TRAVEL TRANSACTIONS

2=TOTAL TRANSACTIONS

3=EQUIPMENT TRANSACTIONS

4=AIRCRAFT TRACTORS

5=SQ FT DORM SPACE

6=WEIGHTED RATIONS SERVED

WORKLOAD INDICATOR,CHANGE:

1,4.89

WORKLOAD INDICATOR,CHANGE:

2,-12.55

WORKLOAD INDICATOR,CHANGE:

3,14.39

WORKLOAD INDICATOR,CHANGE:

4,0

WORKLOAD INDICATOR,CHANGE:

5,7.15

WORKLOAD INDICATOR,CHANGE:

6,-11.34

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN SPLITOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

TACTICAL AIP COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	5180.0	-217.8	4962.2	-4.20
RETAIL SUPPLY OPERATIONS	5208.0	-489.2	4718.8	-9.39
MAINTENANCE OF INSTALLATION EQUIPMENT	1236.0	19.0	1255.0	1.54
OTHER BASE SERVICES	4427.0	-115.0	4312.0	-2.60
MORALE WELFARE & RECREATION	626.0	-9.4	616.6	-1.50
OTHER PERSONNEL SUPPORT	1875.0	-124.4	1750.6	-6.63
BACHELOR HOUSING OPERATIONS	239.0	14.7	253.7	6.13
TOTAL	18791.0	-922.0	17869.0	-4.91

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	84562.0	3966.0	88528.0	4.7
BOS BUDGET	569.9	-82.2	487.7	-14.4
TRANSACTIONS AUDITED	425230.1	-14517.9	410712.2	-3.4
LEAVE AND PAY ACCOUNTS	99646.8	-6901.4	92745.4	-6.9
CIVILIAN PAY RECORDS	14979.4	-1037.4	13942.0	-6.9
MATERIAL & SERVICES TRANSACTIONS	87098.4	-4982.5	82115.9	-5.7

POPULATION INDICATORS:

TOTAL POPULATION SUPPORTED (INCL DEP)	368987.0	-25555.5	343431.5	-6.9
BASE POPULATION	98039.0	-6790.1	91248.9	-6.9
BOS POPULATION	18791.0	-922.0	17869.0	-4.9
MILITARY POPULATION	84645.0	-5862.4	78782.6	-6.9
MISSION POPULATION	79248.0	-5868.0	73380.0	-7.4

SUPPLY INDICATORS:

TOTAL TRANSACTIONS	2888476.0	-391388.5	2497087.5	-13.5
SUPPLY TRANSACTIONS	2396100.0	-380008.0	2016092.0	-15.9
REQUISITIONS	152659.0	-24210.9	128448.1	-15.9
EQUIPMENT TRANSACTIONS	220525.0	31733.5	252258.6	14.4
RECEIPTS	119192.0	-18903.2	100288.8	-15.9
TOTAL INVENTORY ITEM RECORDS	929105.0	-122303.9	806801.1	-13.2
SUPPLY ITEM RECORDS	812221.0	-106917.7	705303.3	-13.2
EQUIPMENT ITEM RECORDS	116884.0	-15386.2	101497.8	-13.2
AVIATION FUEL CONSUMPTION	45291.0	-15288.0	30003.0	-33.8

MAINT OF INSTA EQUIP INDICATORS:

TOTAL VEHICLES	11347.0	0.	11347.0	0.
MILITARY VEHICLES	4482.0	0.	4482.0	0.
AIRCRAFT TRACTORS	404.0	0.	404.0	0.
SPECIAL HANDLING	4078.0	0.	4078.0	0.
NON-MILITARY VEHICLES	6865.0	0.	6865.0	0.
GENERAL PURPOSE AUTO	736.0	0.	736.0	0.
ALL PURPOSE TRUCKS	6129.0	0.	6129.0	0.

BACHELOR HOUSING INDICATORS:

50 FT DORM SPACE	6881.0	-492.0	7373.0	7.1
DORM BEDS	32136.0	2337.0	34475.0	7.3

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED	344877.0	-39109.1	305768.0	-11.3
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ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP

ITERATION OPTION=

3

STOP RUN COMPLETE

EFU'S:5.6

ANNEX 5

Model runs used to work the model backwards (Tables H19,
H20, and H21)

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

1

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

629

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

0

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?

2

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

AIR TRAINING COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	EXIST MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	4148.0	82.4	4230.4	1.99
DETAIL SUPPLY OPERATIONS	3103.0	862.0	3965.0	27.78
MAINTENANCE OF INSTALLATION EQUIPMENT	522.0	-67.7	454.3	-12.98
OTHER BASE SERVICES	3168.0	-561.2	2606.8	-17.71
MORALE WELFARE & RECREATION	502.0	7.0	509.0	1.39
OTHER PERSONNEL SUPPORT	2544.0	304.3	2848.3	11.96
BACHELOR HOUSING OPERATIONS	200.0	2.3	202.3	1.15
TOTAL	14187.0	629.0	14816.0	4.43

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY77 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	76295.0	8538.2	84833.2	11.2
30S BUDGET	431.7	9.3	441.0	2.2
TRANSACTIONS AUDITED	310900.7	7491.5	318392.2	2.4
LEAVE AND PAY ACCOUNTS	85024.6	607.0	85631.7	.7
CIVILIAN PAY RECORDS	24836.0	177.3	25013.3	.7
MATERIAL & SERVICES TRANSACTIONS	64125.2	2812.5	66937.7	4.4
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	253447.0	-80171.9	173275.1	-31.6
BASE POPULATION	64437.0	460.1	64897.1	.7
30S POPULATION	14187.0	629.0	14816.0	4.4
MILITARY POPULATION	42836.0	450.3	43286.3	1.1
STUDENTS	36584.0	1549.3	38133.3	4.2
MISSION POPULATION	50250.0	-168.9	50081.1	-.3
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	983946.7	321997.9	1305944.6	32.7
SUPPLY TRANSACTIONS	818579.0	267881.1	1086460.1	32.7
REQUISITIONS	51417.9	16826.6	68244.5	32.7
EQUIPMENT TRANSACTIONS	68474.2	22408.3	90882.5	32.7
RECEIPTS	45475.6	14882.0	60357.6	32.7
TOTAL INVENTORY ITEM RECORDS	468601.0	172393.2	640994.2	36.8
SUPPLY ITEM RECORDS	396942.8	146030.9	542973.7	36.8
EQUIPMENT ITEM RECORDS	71658.2	26362.4	98020.5	36.8
AVIATION FUEL CONSUMPTION	15407.3	3122.8	18530.2	20.3
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	4089.0	-505.7	3583.3	-12.4
MILITARY VEHICLES	1271.9	-157.3	1114.6	-12.4
AIRCRAFT TRACTOPS	47.1	-5.8	41.3	-12.4
SPECIAL HANDLING	1224.8	-151.5	1073.3	-12.4
NON-MILITARY VEHICLES	2817.1	-348.4	2468.7	-12.4
GENERAL PURPOSE AUTO	562.9	-69.6	493.3	-12.4
ALL PURPOSE TRUCKS	2254.1	-278.8	1975.3	-12.4

BACHELOR HOUSING INDICATORS:

SQ FT DORM SPACE	13536.0	523.4	14059.4	3.9
DORM BEDS	45030.3	957.1	45987.4	2.1

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED	847460.0	-50525.4	796934.6	-6.0-
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ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP

ITERATION OPTION=

3

STOP RUN COMPLETE

SFU'S: 7.5

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

2

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

-1320

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

0

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?

2

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7764.0	-1054.8	6709.2	-11.58
RETAIL SUPPLY OPERATIONS	8159.0	-405.9	7753.1	-4.97
MAINTENANCE OF INSTALLATION EQUIPMENT	2225.0	-161.8	2063.2	-7.27
OTHER BASE SERVICES	8049.0	238.1	8287.1	2.96
MORALE WELFARE & RECREATION	967.0	-46.3	920.7	-4.79
OTHER PERSONNEL SUPPORT	2723.0	116.9	2839.9	4.29
BACHELOR HOUSING OPERATIONS	338.0	-6.5	331.5	-1.92
TOTAL	30225.0	-1320.0	28905.0	-4.37

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	109753.0	-18720.7	91032.3	-17.1
BOS BUDGET	887.3	-83.2	804.1	-7.1
TRANSACTIONS AUDITED	616349.0	-68434.0	547915.0	-11.1
LEAVE AND PAY ACCOUNTS	132016.3	-17839.9	114176.3	-13.5
CIVILIAN PAY RECORDS	21752.6	-2939.5	18813.1	-13.5
MATERIAL & SERVICES TRANSACTIONS	128319.7	-17431.7	110888.0	-13.6
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	344002.0	16648.3	360650.3	4.8
BASE POPULATION	132803.0	-17946.2	114856.8	-13.5
BOS POPULATION	30225.0	-1320.0	28905.0	-4.4
MILITARY POPULATION	111674.0	-14045.3	97628.2	-12.6
MISSION POPULATION	102579.0	-16626.2	85951.8	-16.2
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2842419.0	-353011.5	2489407.5	-12.4
SUPPLY TRANSACTIONS	2376568.0	-295155.3	2081412.6	-12.4
REQUISITIONS	142565.0	-17707.1	124857.9	-12.4
EQUIPMENT TRANSACTIONS	193415.0	-24019.5	169395.5	-12.4
RECEIPTS	129872.0	-16129.6	113742.4	-12.4
TOTAL INVENTORY ITEM RECORDS	1084387.4	-122600.4	961787.1	-11.3
SUPPLY ITEM RECORDS	921863.0	-104225.4	817637.6	-11.3
EQUIPMENT ITEM RECORDS	162524.5	-18374.9	144149.5	-11.3
AVIATION FUEL CONSUMPTION	76682.0	-6662.1	70019.9	-8.7

MAINT OF INSTA EQUIP INDICATORS:

TOTAL MILEAGE	681.0	166.5	847.5	24.4
TOTAL VEHICLE EQUIVALENTS	33200.5	-1940.9	31259.6	-5.8
TOTAL VEHICLES	14601.2	-853.6	13747.6	-5.8
MILITARY VEHICLES	4656.0	-272.2	4383.8	-5.8
AIRCRAFT TRACTORS	320.8	-18.3	302.0	-5.8
SPECIAL HANDLING	4335.2	-253.4	4081.8	-5.8
NON-MILITARY VEHICLES	9945.2	-581.4	9363.8	-5.8
GENERAL PURPOSE AUTO	1220.8	-71.4	1149.4	-5.8
ALL PURPOSE TRUCKS	8724.4	-510.0	8214.4	-5.8

BACHELOR HOUSING INDICATORS:

SQ FT DORM SPACE	9396.4	-629.0	8767.3	-6.7
DORM BEDS	41842.4	-2441.3	39401.1	-5.8

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED	398382.0	39231.4	437613.4	9.8
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ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP

ITERATION OPTION=

3

STOP RUN COMPLETE

SPU'S: 6.6

1

30SPG

AIR FORCE BASE OPERATING SUPPORT
AGGREGATE WORKLOAD INDICATOR MODEL

ENTER COMMANDS (1=ATC,2=SAC,3=TAC):

3

ENTER CHANGE OPTION (1=MANPOWER,2=WORKLOAD):

1

ENTER TYPE OF CHANGE SPEC. (1=ABSOLUTE,2=PERCENT,3=NO OVERALL CHANGE SPEC.):

1

ENTER ABSOLUTE CHANGE:

-3464

ENTER THE NUMBER OF FUNCTIONS FOR WHICH CHANGES WILL BE SPECIFIED:

0

IS THERE A CHANGE IN THE NUMBER OF BASES (1=YES,2=NO)?

2

ENTER PRINT OPTION AS FOLLOWS:

1=DISPLAY MILITARY/CIVILIAN BREAKOUT

2=DISPLAY TOTAL MANPOWER ONLY

PRINT OPTION IS:

2

TACTICAL AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FV78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	5624.0	-1864.2	3759.8	-33.15
DETAIL SUPPLY OPERATIONS	6133.0	-556.0	5577.0	-9.07
MAINTENANCE OF INSTALLATION EQUIPMENT	2183.0	-491.8	1691.2	-22.53
OTHER BASE SERVICES	5373.0	-267.7	5105.3	-4.98
MORALE WELFARE & RECREATION	666.0	-73.7	592.3	-11.06
OTHER PERSONNEL SUPPORT	2055.0	-189.9	1865.1	-9.27
BACHELOR HOUSING OPERATIONS	221.0	-40.6	180.4	-18.39
TOTAL	22255.0	-3464.0	18791.0	-15.57

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

OUTPUT/WORKLOAD

WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE INDICATOR	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	26527.0	-33504.4	55022.6	-37.3
BOS BUDGET	615.1	-190.2	425.0	-30.9
TRANSACTIONS AUDITED	454833.2	-124281.9	330551.4	-27.3
LEAVE AND PAY ACCOUNTS	97203.4	-35132.0	62071.4	-36.1
CIVILIAN PAY RECORDS	14611.1	-5280.9	9330.3	-36.1
MATERIAL & SERVICES TRANSACTIONS	97257.1	-42653.3	54603.8	-43.9
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED(INCL DEP)	256685.0	-26237.9	229847.1	-10.2
BASE POPULATION	95635.0	-34565.2	61069.8	-36.1
BOS POPULATION	22255.0	-3464.0	18791.0	-15.6
MILITARY POPULATION	32202.0	-29475.5	52726.5	-35.9
MISSION POPULATION	73380.0	-31101.2	42278.8	-42.4
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2496977.0	-310175.6	2186801.4	-12.4
SUPPLY TRANSACTIONS	2015998.6	-176602.9	1839395.7	-8.8
REQUISITIONS	120442.2	-11251.6	117190.6	-8.8
EQUIPMENT TRANSACTIONS	252252.0	-113536.1	138715.9	-45.0
RECEIPTS	100284.2	-8785.0	91499.2	-8.8
TOTAL INVENTORY ITEM RECORDS	1160355.0	-139005.4	1021349.6	-12.0
SUPPLY ITEM RECORDS	1014379.1	-121518.1	892861.0	-12.0
EQUIPMENT ITEM RECORDS	145975.9	-17487.3	128488.6	-12.0
AVIATION FUEL CONSUMPTION	74197.3	-17375.7	56821.6	-23.4
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL VEHICLES	11347.0	-3445.2	7901.8	-30.4
MILITARY VEHICLES	4482.0	-1380.8	3101.2	-30.4
AIRCRAFT TRACTORS	404.0	-122.7	281.3	-30.4
SPECIAL HANDLING	4079.0	-1238.2	2839.8	-30.4
NON-MILITARY VEHICLES	6865.0	-2084.4	4780.7	-30.4
GENERAL PURPOSE AUTO	736.0	-223.5	512.5	-30.4
ALL PURPOSE TRUCKS	6129.0	-1860.9	4268.1	-30.4

BACHELOR HOUSING INDICATORS:

SQ FT DORM SPACE
DORM BEDS

7373.0	-2506.1	4666.9	-34.0
34475.0	-11903.8	22571.2	-34.5

OTHER PERSONNEL SUPPORT:

WEIGHTED RATIONS SERVED

385784.0	-33394.3	271889.7	-11.1
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ENTER ITERATION OPTION AS FOLLOWS:

1=ACCUMULATE CHANGES, 2=BEGIN NEW CYCLE, 3=STOP
ITERATION OPTION=

3

STOP RUN COMPLETE

ANNEX 6

**Listings of data file changes for working the model with
FY77 data**

**NOTE: Descriptive indicator formats did not change and,
therefore, are not listed.**

LIST ATCFL1

20	1,036.
40	AIR TRAINING COMMAND
60	7. 24. 17. .001 6. 42. 3. 10.
80	4148.
100	3103.
120	522.
140	3168.
160	502.
180	2544.
200	200.
220	0.
240	0.
260	0.
280	0.
300	0.
320	0.
340	0.
360	64437.
380	0.
400	76295.
420	818579.
440	4009.
460	253447.
480	13538.
500	42836.
520	36584.
540	847460.
560	'FADM' 59.37 0.
580	ADMINISTRATION
600	'FPSO' 58.18 165.
620	RETAIL SUPPLY OPERATIONS
640	'FMIE' 42.32 0.
660	MAINTENANCE OF INSTALLATION EQUIPMENT
680	'FOBS' 64.48 193.
700	OTHER BASE SERVICES
720	'FMWR' 54.30 0.
740	MORALE WELFARE & RECREATION
760	'FOPS' 13.52 78.
780	OTHER PERSONNEL SUPPORT
800	'FSDO' 44.13 0.
820	BACHELOR HOUSING OPERATIONS

LIST SACFL1

20	1,436.
40	STRATEGIC AIR COMMAND
60	7. 24. 17. .001 6. 43. 2. 10.
80	7764.
100	8159.
120	2225.
140	8049.
160	967.
180	2723.
200	338.
220	0.
240	0.
260	0.
280	0.
300	0.
320	0.
340	0.
360	132903.
380	109753.
400	921863.
420	76682.
440	4656.
460	681.
480	344002.
500	10719.
520	111674.
540	398382.
560	'GADN' 79.93 0.
580	ADMINISTRATION
600	'GRSO' 80.20 165.
620	RETAIL SUPPLY OPERATIONS
640	'GIII' 49.66 0.
660	MAINTENANCE OF INSTALLATION EQUIPMENT
680	'GOSS' 80.24 193.
700	OTHER BASE SERVICES
720	'GMMR' 65.56 0.
740	MOBILE WELFARE & RECREATION
760	'GOPS' 66.25 78.
780	OTHER PERSONNEL SUPPORT
800	'GMBH' 81.38 0.
820	BACHELOR HOUSING OPERATIONS

LIST TACFL

20	1,436.
40	TACTICAL AIR COMMAND
60	7. 24. 17. .001 6. 41. 3. 10.
80	5624.
100	6133.
120	2183.
140	5373.
160	666.
180	2055.
200	221.
220	0.
240	0.
260	0.
280	0.
300	0.
320	0.
340	0.
360	95635.
380	88527.
400	2496977.
420	252252.
440	404.
460	256085.
480	7373.
500	82202.
520	305784.
540	0.
560	'HADM' 75.51 0.
580	ADMINISTRATION
600	'HRSO' 80.32 165.
620	RETAIL SUPPLY OPERATIONS
640	'HMIE' 75.81 0.
660	MAINTENANCE OF INSTALLATION EQUIPMENT
680	'HOBS' 83.99 193.
700	OTHER BASE SERVICES
720	'HMNR' 62.30 0.
740	MORALE WELFARE & RECREATION
760	'HOPS' 56.00 78.
780	OTHER PERSONNEL SUPPORT
800	'HSHO' 34.62 0.
820	BACHELOR HOUSING OPERATIONS

APPENDIX I

GEBOS VALIDATION THROUGH STANDARDS APPLICATION

GEBOS VALIDATION THROUGH STANDARDS APPLICATION

In order to make GEBOS a fully useful tool, the model requires validation against external independent estimating procedures. One independent source of estimates on how manpower and workload changes occur is manpower standards. This appendix compares a set of manpower and workload changes produced by the GEBOS model with a set of changes produced from work center standards.

METHODOLOGY

SAC Retail Supply Operations was selected for the validation exercise. This functional category was used because it represents a major part of BOS (27.3% for SAC) and has a number of descriptive and highly correlated workload indicators. Most SAC command supply work center manpower standards were readily available to the project team.

The methodology used was to apply a 10% manpower increase to the Retail Supply Operations functional category in GEBOS, allowing all other functional categories and workload indicators to change based on the interactive support-on-support relationships in the model. Other model specifications of manpower changes to Retail Supply Operations could have been used to produce an impact on supply workload indicators. Other manpower specifications would likely produce slack manpower in other functions, and generate non-optimal use of resources. The use of a 10% manpower increase illustrates the form of a balanced change of workload capability and manpower resources.

Figure I.1 illustrates the output from GEBOS. The primary supply indicators are total transactions, total inventory item records, and aviation fuel consumption. The model predicted these indicators would increase respectively 24.7%, 22.5%, and 23.5%.

The model equations predicted that supply workload levels would be elastic with respect to manpower. That is, a 10% change in supply manpower produced a more than 10% change in supply workload capability.

Figure I.1

GEGOS Estimate of the Impact

A Ten Percent Retail Supply Operations Manpower Increase

STRATEGIC AIR COMMAND

FUNCTIONAL MANPOWER (TOTAL)

FUNCTION	FY78 MANPOWER	CHANGE	RESULTANT MANPOWER	PERCENT CHANGE
ADMINISTRATION	7047.4	1435.9	8483.3	20.38
RETAIL SUPPLY OPERATIONS	7398.6	739.9	8138.4	10.00
MAINTENANCE OF INSTALLATION EQUIPMENT	2179.0	197.7	2376.7	9.07
OTHER BASE SERVICES	7818.7	1244.6	9063.2	15.92
MORALE WELFARE & RECREATION	903.0	86.3	989.3	9.56
OTHER PERSONNEL SUPPORT	2719.6	176.8	2896.4	6.50
BACHELOR HOUSING OPERATIONS	338.8	5.4	344.2	1.60
TOTAL	28905.0	3936.6	32841.6	13.62

MANPOWER SLACK VARIABLES

FUNCTION	SLACK
ADMINISTRATION	0.
RETAIL SUPPLY OPERATIONS	0.
MAINTENANCE OF INSTALLATION EQUIPMENT	0.
OTHER BASE SERVICES	0.
MORALE WELFARE & RECREATION	0.
OTHER PERSONNEL SUPPORT	0.
BACHELOR HOUSING OPERATIONS	0.

Figure I.1 (cont.)

OUTPUT/WORKLOAD				
WORKLOAD INDICATOR	FY78 INDICATOR	CHANGE	RESULTANT INDICATOR	PERCENT CHANGE
ADMINISTRATION INDICATORS:				
TRAVEL TRANSACTIONS PROCESSED	106698.6	31207.0	137905.6	29.2
BOS BUDGET	882.0	115.3	997.3	13.1
TRANSACTIONS AUDITED	610585.9	124903.0	735489.0	20.5
LEAVE AND PAY ACCOUNTS	130513.5	32560.6	163074.1	24.9
CIVILIAN PAY RECORDS	21533.4	5372.2	26905.6	24.9
MATERIAL & SERVICES TRANSACTIONS	17937.7	4618.8	22456.4	25.2
POPULATION INDICATORS:				
TOTAL POPULATION SUPPORTED (INCL DEP)	412286.2	102857.5	515143.7	24.9
BASE POPULATION	131301.3	32757.2	164058.5	24.9
BOS POPULATION	28905.0	3936.6	32841.6	13.6
MILITARY POPULATION	111606.1	27843.6	139449.7	24.9
STUDENTS	0.	0.	0.	0.
MISSION POPULATION	102396.3	28820.6	131216.9	28.1
SUPPLY INDICATORS:				
TOTAL TRANSACTIONS	2841968.0	702142.6	3544110.6	24.7
SUPPLY TRANSACTIONS	2317056.5	572456.8	2889513.3	24.7
REQUISITIONS	141245.8	34896.5	176142.3	24.7
EQUIPMENT TRANSACTIONS	254924.5	62982.2	317906.7	24.7
RECEIPTS	128741.2	31807.1	160548.2	24.7
TOTAL INVENTORY ITEM RECORDS	1084507.3	243915.2	1328422.6	22.5
SUPPLY ITEM RECORDS	921729.9	207305.2	1129035.0	22.5
EQUIPMENT ITEM RECORDS	162777.5	36610.1	199387.6	22.5
AVIATION FUEL CONSUMPTION	79276.9	18606.9	97883.8	23.5
MAINT OF INSTA EQUIP INDICATORS:				
TOTAL MILEAGE	879.9	63.3	943.2	7.2
TOTAL VEHICLE EQUIVALENTS	33197.9	3781.5	36979.4	11.4
TOTAL VEHICLES	14600.0	1663.1	16263.1	11.4
MILITARY VEHICLES	4655.6	530.3	5185.9	11.4
AIRCRAFT TRACTORS	320.8	36.5	357.3	11.4
SPECIAL HANDLING	4334.9	493.8	4828.6	11.4
NON-MILITARY VEHICLES	9944.4	1132.8	11077.2	11.4
GENERAL PURPOSE AUTO	1220.7	139.0	1359.8	11.4
ALL PURPOSE TRUCKS	8723.7	993.7	9717.4	11.4
BACHELOR HOUSING INDICATORS:				
30 FT DORM SPACE	9395.0	1247.4	10642.3	13.3
DORM BEDS	48272.5	9976.4	58248.8	20.7
OTHER PERSONNEL SUPPORT:				
WEIGHTED RATIONS SERVED	456162.9	36950.1	493112.9	8.1

STANDARDS APPLICATION

The next step in the validation exercise was to price out the workload changes produced by the model into work center manpower standards, where applicable. A set of command work center manpower standards had been obtained from AFMEA as of June 1978. These standards covered most work centers in functions 4100 - 4163. Selected additional functional standards were also acquired from AFMEA. The work center manpower standard equations and workload factors are listed in Table I.1.

Workload indicators from GEBOS were command-level output measures. Therefore, command total output was divided by the number of bases (26) to determine the average base-level workload.

The average base level workload levels were applied to 15 functional work centers. The manhours required to perform the FY78 monthly workload and the increased workload were computed. These figures are given in Table I.2. The individual work center manpower changes ranged from 5.3% to 18.1%. The average overall manhour increase that resulted from the model's workload changes was 11.4%. This figure compared quite favorably with the model's estimate of 10%.

These 15 functions accounted for 50% of the supply manpower, based on 144 available manhours per month ($21854 \text{ manhours} \div 144 = 151.8 \text{ spaces} \div 303.8 \text{ spaces per base} = .500$). Thus half the supply manpower on a typical SAC base was directly estimable from model workload indicators.

The next step in the validation exercise was to determine if the functional manpower estimated from the workload was consistent with other estimates of functional manpower. The most detailed command manpower distribution readily available showed end FY76 functional manpower by 4-digit functional code. The proportion of manpower in each 4-digit function was computed and the number of available manhours by function for a typical base was computed, based on 144 hours per space and 303.8 spaces per base. These figures are given in Table I.3.

TABLE I.1

RETAIL SUPPLY OPERATIONS WORK CENTER MANPOWER STANDARDS FOR SAC

Function	Workload Factor	Standard Equation
4100	Subordinate manpower	$6.012x^{.717}$
4111	Authorized military personnel	$22.04 + 31.99\sqrt{x}$
4120	Subordinate manpower	$8.12 + 4.341x$
4121	Line items received and turn-ins inspected	$34.04x^{.3486}$
4122	Supply and equipment transactions	$.3434x^{.7532}$
4123	Supply and equipment transactions	$1.332x^{.6844}$
4124	WRM/mobility kit line items	$(5.863 + .4994\sqrt{x})^2$
4125	Self-service line items	$(1.062 + .8591\sqrt{x})^2$
4126	Supply and equipment transactions	$1163 + .009479x$
4130	Subordinate manpower	$26.53x^{.841}$
4131	Item records	$22.69 + 3.702\sqrt{x}$
4132	Authorized military personnel	$6.754 + 1.086x$
4133	Item records	$317.1 + .01153x$
4134	Dollar value of inventory on-hand	$169.1 + .0001016x$
4135	Base supply manpower	$212.1 + .8418x$
4140	Subordinate manpower	$190.7 + 2.34x$
4141	Subordinate manpower	$4.665 + 39.90\sqrt{x}$
414102	Supply and equipment transactions	$19.88^{.3534}$
414104	Bench stock line items	$56.97 + 2.522x$
414105	Bench stock line items	$85.23 + .08467x$
414106	Repair cycle line items	$96.55 + .06938x$
414107	Avionics maintenance line items	$377.9 + .1639x$
414108	Assigned aircraft/missile systems	$4.42 + 29.39x$
4142	Subordinate manpower	$85.8 + 6.61x$
414201	Supply transactions	$304.7 + .004971x$
414202	Requisitions	$691.4 + 134x$
414203	Local purchase requisitions	$75.37 + .1896x$
4150	Subordinate manpower	$29.96 + 8.828x$
4151	Subordinate manpower	$11.87x^{.822}$

TABLE I.1 (cont.)

RETAIL SUPPLY OPERATIONS WORK CENTER MANPOWER STANDARDS FOR SAC

Function	Workload Factor	Standard Equation
415101	Tool kits	$12.4 + .55x$
415102	Authorized military and civilian population	$33.28 + 1378x$
4152	Subordinate manpower	$26.98 + 10.8x$
415202	Registered equipment	$.7208x^{.817}$
415203	Equipment transactions	$141.9 + .007824x$
415204	AF Form 601-b line items	$203.2 + .9886x$
415205	SPR processed equipment transactions	$12.17x^{.6293}$
4160	Subordinate manpower	$49.67 + 5.973x$
4161	Supply and equipment transactions	$4.766x^{.2967}$
416102	Supply and equipment transactions	$5.305x^{.4271}$
4162	Requisitions	$812.7 + .07137x$
4163	Supply and equipment transactions	$(13.68 + .038835\sqrt{x})^2$
4170	N/A	—
4171	Mobile unit filter separators	$212.9 + 2.664x$ 1
	Demineralized water trucks	+ 14.63x 2
	63130/50 authorizations	+ .3205x 3
4172	Gallons received by truck and railroad	$193.2 + .2151x$ 1
	Gallons received by pipeline, barge, tanker	+ .0634x 2
	Pipeline rate per hour	- .00262x 3
	Gallons issued to mobile units	+ .1313x 4
	fuel tanks (over 50K)	+ 42.84x 5
	fuel tanks (25-50K)	+ 35.69x 6
4174	Gallons issued: aviation fuel + ground fuel	$30.4x^{.3527}$
4175	Gallons received per year	$.1332 + .0002226x$
4176	AF Form 1238	$1.318 + .001327x$
4177	Vehicles serviced/month	$123.1 + .08719x$
4180	N/A	—
1250	N/A	—
1251	Monthly dollar amount completed	$742 + .0014x$ 1
	Purchase line items received	+ .526x 2
	Contracts administered	+ 3.631x 3

TABLE I.2

MODEL WORKLOAD CHANGES APPLIED TO WORK CENTER MANPOWER STANDARDS

Function	Workload Indicator	Model FY78 Workload Per Base	Resultant Workload	Percent Increase	Base FY78 Manhours	Resultant Manhours	Percent Increase
4122	Supply and equipment transactions	98923	123357	24.7	1987	2347	18.1
4123	Supply and equipment transactions	98923	123357	24.7	3494	4065	16.3
4126	Supply and equipment transactions	98923	123357	24.7	2101	2332	11.0
4131	Item records	41712	51097	22.5	779	860	10.4
4133	Item records	41712	51097	22.5	798	906	13.5
4135	Base supply manpower	304	334	10.0	468	493	5.3
414102	Supply and equipment transactions	98923	123357	24.7	1158	1252	8.1
414201	Supply transactions	89118	111130	24.7	748	857	14.6
414202	Requisitions	5433	6775	24.7	1419	1599	12.7
415203	Equipment transactions	9805	12227	24.7	219	238	8.7
4161	Supply and equipment transactions	98923	123357	24.7	145	154	6.2
416102	Supply and equipment transactions	98923	123357	24.7	721	793	10.0
4162	Requisitions	5433	6755	24.7	1200	1296	8.0
4163	Supply and equipment transactions	93923	123357	24.7	663	737	11.1
4174	Ground and aviation fuel consumption	3,149,000	3,889,000	23.5	5954	6414	7.7
TOTAL					21854	24343	11.4

TABLE I.3
SAC MANPOWER DISTRIBUTION
As of Sept 1975

Function	Proportion	Proportional Available Manhours
4100	.0098	429
4111	.0125	547
4120	.0083	363
4121	.0193	844
4122	.0454	1986
4123	.0760	3325
4124	.0060	263
4125	.0114	499
4126	.0476	2083
4130	.0085	372
4131	.0180	788
4132	.0072	315
4133	.0186	814
4134	.0085	372
4135	.0101	442
4140	.0085	372
4141	.0899	3933
4142	.0623	2726
4150	.0069	302
4151	.0374	1636
4152	.0475	2078
4160	.0040	175
4161	.0524	2293
4162	.0299	1308
4163	.0166	726
4170	.0084	368
4171	.0115	503
4172	.0266	1164
4174	.1471	6436

TABLE I.3 (cont.)
SAC MANPOWER DISTRIBUTION
As of Sept 1975

Function	Proportion	Proportional Available Manhours
4175	.0109	477
4176	.0152	665
4177	.0115	503
4180	.0050	219
1250	.0003	13
1251	.1009	4415
TOTAL	1.0000	43,754

The manhours estimated by the functional distribution and those estimated from workload indicators can be directly compared for 9 functions. These functions are presented in Table I.4. The two estimates of manhours are remarkably consistent, especially considering the manpower distribution differed two years from the workload, and in many cases the average workload was derived from one month's data. All workload estimates are within 10% of one another, and the average discrepancy was only 2.6%.

The next step was to extend the workload projections to additional functions. Additional manpower changes could be computed from additional workload data, by computing approximate workload from estimated manpower. Additional workload data was collected on selected indicators in 1977 that was not available in 1978. These indicators were bench stock items and repair cycle items. The average value of these items for FY77 was used as the workload estimate.

For many functions an estimate of the average available manhours could be computed from the functional manpower distribution in Table I.4. For example, the workload indicator for function 4125 is self-service store line items. While no data on the workload indicator was readily available, it was possible to estimate that the workload indicator would have a typical value of 613, based on the proportional functional manhours and the standard equation.

The third source of additional workload estimates was for functions that take subordinate manpower as their workload indicator. For example, the workload indicator for function 4120 was the manpower in functions 4121-4126. Once the manpower had been estimated for the subordinate functions, it served as the workload indicator for function 4120. Thus the manpower in function 4120 was derived from other functional manpower.

The workload indicator values, percentage increases, and resultant workload value for all functions are listed in Table I.5. The manhour figures corresponding to these workload levels are listed in Table I.6.

Table I.4
FUNCTIONAL MANPOWER ESTIMATED FROM MODEL WORKLOAD AND FUNCTIONAL
DISTRIBUTION

Function	Manhours Estimated From Model Workload	Manhours Estimated From Manpower Distribution	Percent Difference
4122	1987	1986	0.1
4123	3494	3325	4.8
4126	2101	2083	0.9
4131	779	788	-1.2
4133	798	814	2.0
4135	468	442	5.9
4162	1200	1308	-9.0
4163	663	726	-9.5
4174	5954	6436	-7.5
TOTAL	17444	17908	-2.6

TABLE I.5

DETAILED WORK CENTER WORKLOAD INDICATORS FOR SAC

Function	Workload Indicator	Source	Value	Percent Increase	Resultant Value
4100	Subordinate manpower	Derived	284	13.1	321
4111	Authorized military personnel	Standard	269.3	10.0	296.2
4120	Subordinate manpower	Derived	63.8	14.9	73.3
4121	Line items received and turn-ins inspected	Standard	9997	22.5	12246
4122	Supply and equipment transactions	Model	98923	24.7	123357
4123	Supply and equipment transactions	Model	98923	24.7	123357
4124	WRM/Mobility kit line items	Standard	430	22.5	527
4125	Self-service line items	Standard	613	22.5	751
4126	Supply and equipment transactions	Model	98923	24.7	123357
4130	Subordinate manpower	Derived	19.0	10.5	21.0
4131	Item records	Model	41712	22.5	51097
4132	Authorized military personnel	Derive	284	10.0	312
4133	Item records	Model	41712	22.5	51097
4134	\$ value inventory on-hand	Standard	1.997M	22.5	2.446M
4135	Base supply manpower	Model	304	10.0	334
4140	Subordinate manpower	Derived	44.6	13.1	50.4
4141	Subordinate manpower	Derived	24.3	12.7	27.4
414102	Supply and equipment transactions	Model	98923	24.7	123357
414104	Bench stock line items	77 Data	6984	22.5	8555

TABLE I.5 (cont.)
DETAILED WORK CENTER WORKLOAD INDICATORS FOR SAC

Function	Workload Indicator	Source	Value	Percent Increase	Resultant Value
414105	Bench stock line items	77 Data	6984	22.5	8555
414106	Repair cycle line items	77 Data	5497	22.5	6735
414107	Avionics maintenance squad items	Upper Bound	1471	22.5	1802
41408	Assigned aircraft/missile systems	Upper Bound	10	20.0	12
4142	Subordinate manpower	Derived	17.5	14.3	20.0
414201	Supply transactions	Model	89118	24.7	111130
414202	Requisitions Submitted	Model	5433	24.7	6775
414203	Local purchase requisitions	Standard	1501	24.7	1872
4150	Subordinate manpower	Derived	25.0	18.7	29.7
4151	Subordinate manpower	Derived	10.8	22.4	13.2
415101	Tool Kits	Standard	1468	22.5	1799
415102	Authorized military and civilian population	Model	5050	24.9	6307
4152	Subordinate manpower	Derived	12.5	15.7	14.5
415202	Registered equipment	Upper Bound	1000	22.5	1225
415203	Equipment transaction	Model	9805	24.7	12227
415204	AF Form 601-b line item	Upper Bound	700	22.5	858
415205	SPR Processed equipment transaction	Upper Bound	350	24.7	436
4160	Subordinate manpower	Derived	19.0	8.9	20.7
4161	Supply and equipment transactions	Model	98923	24.7	123357

TABLE I.5 (cont.)
DETAILED WORK CENTER WORKLOAD INDICATORS FOR SAC

Function	Workload Indicator	Source	Value	Percent Increase	Resultant Value
416102	Supply and equipment transactions	Model	98923	24.7	123357
4162	Requisitions	Model	5433	24.7	6775
4163	Supply and equipment transactions	Model	98923	24.7	123357
4170	Unknown	Upper Bound	66.9	10.0	73.6
4171	Mobile unit filter separators	Upper Bound	5	0	5
	Demin. water trucks	Upper Bound	2	0	2
	63130/50 authorizations	Upper Bound	772	23.5	954
4172	Gallons received by truck and railroad	Upper Bound	4148	23.5	5123
	Gallons received by pipeline, barge, tanker	Upper Bound	0	0	0
	Pipeline rater per hour	Upper Bound	0	0	0
	Gallons issued to mobile units	Upper Bound	0	0	0
	Fuel tanks (units + 50K)	Upper Bound	1	0	1
	Fuel tanks (units 25-50K)	Upper Bound	1	0	1
4174	Gallons issued: aviation fuel + ground fuel	Model	3.149M	23.5	3.889M
4175	Gallons LOX received per year	Upper Bound	2.142M	0	2.142M
4176	AF Form 1238	Standard	500137	23.5	617669

TABLE I.5 (cont.)
DETAILED WORK CENTER WORKLOAD INDICATORS FOR SAC

Function	Workload Indicator	Source	Value	Percent Increase	Resultant Value
4177	Vehicles serviced/month	Standard	4357	11.4	4854
4180	Unknown	Upper Bound	-	-	-
1250	Unknown	Upper Bound	-	0	-
1251	Monthly dollar amount completed	Upper Bound	0	0	0
	Purchase request line items received	Upper Bound	6221	22.5	8110
	Total active contracts administered	Upper Bound	50	0	50

TABLE I.6

ESTIMATED MANHOUR CHANGES BY FUNCTION FOR SAC RETAIL SUPPLY OPERATIONS

Function	Source of Workload	Manhours Estimate	Resultant	Percent
			Manhours	Increase
4100	Derived	345	377	9.1
4111	Standard	547	573	4.8
4120	Derived	285	326	14.4
4121	Standard	844	906	7.3
4122	Model	1987	2347	18.1
4123	Model	3494	4065	16.3
4124	Standard	263	300	14.1
4125	Standard	499	606	21.4
4126	Model	2101	2332	11.0
4130	Derived	315	343	9.0
4131	Model	779	860	10.4
4132	Standard	315	346	9.8
4133	Model	798	906	13.5
4134	Standard	372	418	12.4
4135	Model	468	493	5.3
4140	Standard	295	309	4.7
4141	Derived	201	214	6.5
414102	Model	1158	1252	8.1
414104	77 Data	268	290	8.2
414105	77 Data	677	810	19.6
414106	77 Data	478	564	18.0
414107	Upper Bound	619	673	8.7
414108	Upper Bound	298	356	19.5
4142	Derived	201	218	8.5
414201	Model	748	857	14.6
414202	Model	1419	1599	12.7
414203	Standard	360	428	18.9
4150	Derived	251	292	16.4
4151	Derived	85	99	16.5

TABLE I.6 (cont.)

ESTIMATED MANHOUR CHANGES BY FUNCTION FOR SAC RETAIL SUPPLY OPERATIONS

Function	Source of Workload Manhours Estimate		Resultant Manhours	Percent Increase
415101	Standard	820	1002	22.2
415102	Standard	729	902	23.7
4152	Derived	162	184	15.5
415202	Upper Bound	204	240	17.6
415203	Model	219	238	8.7
415204	Upper Bound	895	1051	17.4
415205	Upper Bound	486	558	14.8
4160	Derived	163	173	6.3
4161	Model	145	154	6.2
416102	Model	721	793	10.0
4162	Model	1200	1296	8.0
4163	Model	663	737	11.1
4170	Upper Bound	363	399	10.0
4171	Upper Bound	503	561	11.6
4172	Upper Bound	1164	1374	18.0
4174	Model	5954	6414	7.7
4175	Upper Bound	477	477	0.0
4176	Standard	665	821	23.5
4177	Standard	503	546	8.6
4180	Upper Bound	219	263	20.0
1250	Upper Bound	13	13	0.0
1251	Upper Bound	4406	5190	17.8
TOTAL	Model Workload	21854	24343	11.4
TOTAL	Model + Standard + Derived Workload	31497	35390	12.4
TOTAL	All Workload	41144	46545	13.1

The total percentage manpower increase for workload factors covered by the model, FY77 workload, and subordinate manpower was 12.4%. Seventy-two percent of the manpower in the functional category was covered by this estimate.

The last group of functions included those with multiple workload indicators, those whose workload indicators were impossible to project accurately, and those with unknown standards equations. For these functions it was impossible to determine an accurate estimate of workload levels. Therefore, reasonable upper bounds were set on workload indicators. That is, it was not possible to determine how much workload values would increase to be consistent with other supply increases, or whether particular workload indicators would remain fixed or variable, estimates were made favoring large workload increases. Thus, the estimates produced for these functions probably overestimated the manpower increase, but set an approximate upper bound for the manpower change.

The results for all functional manpower increases are also shown in Table I.6. The total, upper bound on manpower increase is 13.1%. This estimate covered 94% of the manpower in the Retail Supply Operations functional category.

CONCLUSIONS

The workload change produced by a 10% model manpower increase yielded from 11.4 to 13.1% when applied to the work center standards. Thus, the model estimates the manpower change to be somewhat less than that estimated by the standards, but in general the model manpower change is consistent, in terms of order-of-magnitude, with the standard. Considering the many assumptions and sources of bias or error that were encountered, the model estimates appear quite reasonable.

Some of the potential sources for bias in the manpower estimates are outlined below.

Authorizations Versus Requirements

The GEBOS model dealt with authorized manpower spaces, while the standards were based on total requirements. To the degree that requirements were not fully authorized, GEBOS would overestimate manpower productivity. This could be a reason why standards produced a larger manpower estimate than GEBOS. However, there was no empirical evidence of this occurring.

Fractional Manpower and Manhours

The manpower changes in the standards application exercise were measured in terms of manhours. Actual manpower changes are made in whole numbers of spaces.

There are separate rules for rounding military and civilian manhours to spaces. Fractional civilian manhours round up to the next highest whole number. Military manhours round either up or down depending on the number of spaces in the function and the amount of fractional manpower.

Since 80.2% of the supply manpower is military, application of the fractional manpower rule for military manpower is likely to result in a smaller manpower increase than the amount computed in terms of manhours. This factor could account for the standards estimated manpower change to be larger than the model's manpower change.

Number of Work Centers

The validation calculations, taking total workload and dividing by the number of bases, have the implicit assumption that there is one of each functional work center per base. Where there are more than 26 work centers and there are linear standards equations, the presence of a positive manhour intercept means the manpower change would be overestimated. That is with more work centers more manpower is related to fixed costs and consequently a given change in workload will produce a smaller manpower change. If there were fewer than 26 work centers, the manpower change may be underestimated.

Nonlinear Biases

Many of the standards equations are of a nonlinear form, such as AX^b . For nonlinear forms, such as the power curve, it is necessary to know the complete distribution of workload to accurately estimate manpower. However, any distributional errors in workload are likely to be small for the distribution of workloads encountered in SAC.

Missing Standards

Approximately 6.0% of the total estimated manhours were not accounted for in the standards estimation. There apparently were some work centers and standards omitted. Since this is only a small percentage of manpower, it would not alter results appreciably.

Out-of-Date Standards

The standards used were those available as of June 1978. In some cases standards could have been replaced by newer standards. New standards would likely have higher workload to manpower ratios.

Regression Coefficient Biases

The aggregate workload equations in GEBOS use only the most significant workload indicators. The degree to which other indicators produce manpower changes that are uncorrelated with the model workload indicators could result in regression bias. It is not possible to predict in advance how the aggregate regression relationship is biased. Based on the results of the validation exercise, the regression constant could be slightly smaller than originally estimated.

In conclusion, the application of work center standards can be used to validate GEBOS manpower equations. The workload changes produced by a 10% manpower change in the model yield about a 12% change from standards application. The 2% difference is probably not significant given the numerous assumptions, approximations, and sources for error. The key finding from GEBOS, that supply workload is highly elastic with respect to supply manpower was upheld by the standards. Therefore, the aggregate manpower/workload relationship used in GEBOS appears consistent with the standards.

For full model validation, the process outlined above could be repeated (with more up-to-date data where appropriate) for all major functional categories. It would, of course, be very time consuming considering the number of work centers and commands involved. As addressed elsewhere in this report, it is probably preferable to use this technique on a selective basis. When full mission programming capability is available in the model, comparison of model outputs with the results of active command application of programmed force structure changes should provide the most reliable basis for validation.

APPENDIX J
MISSION ANALYSIS

MISSION ANALYSIS

This appendix describes the analysis of mission-BOS relationships for the development of the prototype mission-BOS model.

The investigation of measures of mission capability was the first task in the development of mission-BOS relationships. Annex 1 to this appendix describes this investigation. Annex 1 also describes the conceptual framework of the BOS mission extension.

The development of mission factors began with the analysis of base population by program element and organization. Selected bases in SAC and TAC were investigated as to manpower.

Manpower outside of BOS was divided by the aircraft inventory to determine the manpower per aircraft factor. The average manpower per F-111D was 49.6 spaces, 69% of which was in the primary program element. The average figure probably overstates the true variable manpower per aircraft somewhat. Some of the manpower requirements would not vary directly with additional manpower increments.

Aircraft flying hours was then analyzed as to its relationship with supply indicators. Since fuel consumption was a workload indicator for the Retail Supply Operation Function, it was used as the principal link between flying hours in primary and subordinate program elements. Table J.1 displays the manpower for Cannon AFB in TAC.

The analysis of mission data continued with the collection of data on aircraft, flying hours, and sorties. The data was obtained from the Data Base Management Division in the Directorate of Programs (PAXRB). The sources were:

- Air Force Inventory of Aerospace Vehicles by Station (G033)

TABLE J.1
MANPOWER DISTRIBUTION FOR CANNON AFB

Command	Program Element	Description	Manpower	Percent
TAC	27129	F-111D Squadrons	2417	54.0
TAC	27594	Real Property Maintenance	347	7.8
TAC	27596	Base Operating Support	960	21.4
TAC	87711	Medical	225	5.0
TAC	Miscellaneous	---	288	6.4
CSV	Miscellaneous	---	144	3.2
Misc.	---	---	99	2.2
Total			4480	100.0

Source: Command manpower data bank for 4th quarter FY78, as of September 1978.

- Quarterly Air Force Flying Hours, Landings, Sorties by Organization (SSA-21)

Table J.2 lists the aircraft data for selected TAC bases derived from these reports.

Fuel consumption per aircraft flying hour was obtained from the USAF Cost and Planning Factors Guide (.AFP 173-13 (U), 31 May 1979). Fuel consumption rates were applied to average monthly flying hours for the TAC bases listed in Table J.2.

Base aviation fuel consumption estimated from flying hours was 22% below actual monthly fuel consumption for end FY78. There are several possible reasons for this discrepancy. First, flying hour data were averaged over three quarters of FY78. Considerable quarterly flying hour variability existed, so an effort was made to reduce variability through averaging. Secondly, fuel consumption data did not cover the same time period as the flying hours. Finally, transient aircraft fuel consumption could introduce considerable additional variability in fuel consumption.

Actual fuel consumption for TAC was shown to be highly correlated with total supply transactions, total item records, and aircraft tractors. The relationships between fuel consumption, supply transactions, and item records were used to relate flying hours to the Retail Supply Operations workload indicators. Three equations exist between manpower and supply workload for TAC:

$$RSO = 126.1 + .0040 (\text{total item records}) r^2 = .863 (1)$$

$$RSO = 235.0 + .0320 (\text{aviation fuel consumption}) r^2 = .562 (2)$$

$$RSO = 124.0 + .00125 (\text{total transactions}) r^2 = .881 (3)$$

Solving these three equations with respect to fuel consumption finds the following aggregate results:

TABLE J.2
AIRCRAFT DATA FOR SELECTED TAC BASES

Base	Aircraft M/D/S ^a	Number ^a	Flying Hours ^b	Sorties ^b	Average Flying Hours/Sortie
Cannon	F-111D	71	11,656	4,757	2.45
England	A007D	64	13,012	7,466	1.74
Holloman	F105A	51	5,627	4,086	1.38
	F015B	4	495	322	1.54
	T038A	76	13,226	12,910	1.02
	T038B	39	5,717	6,211	0.92
	UH001N	2	455	285	1.60
Luke	UH001P	3	852	711	1.20
	F004C	73	12,554	9,369	1.34
	F015A	41	6,530	5,228	1.25
	F015B	26	3,237	2,334	1.39
	FTF104G	22	2,332	2,150	1.08
	FXF104G	34	4,045	3,673	1.10
	T033A	4	786	463	1.70
	CH003E	6	1,207	747	1.62
Moody	F004E	34	11,484	7,990	1.44

^aFrom Inventory of Aerospace Vehicles by Station, September 1978.

^bFrom Quarterly USAF Flying Hours, Landings, Sorties by Organization for 1st, 2nd, and 4th Quarter, 1978.

1000 gallons fuel consumption = 8.0 total inventory item records

1000 gallons fuel consumption = 25.6 total transactions

Based on these relationships, aviation fuel consumption can be related to supply workload indicators and manpower. The F-111D was selected as the prototype aircraft to be used in the mission model. The F-111D has an average planned fuel consumption of 1500 gallons per hour. However, an arbitrary reduction in the factor was made to round the aggregate supply indicator change to 5% for a specific level of activity. Therefore, the factors used in the prototype model became:

- 1306 gallons fuel consumption per flying hour
- 11.43 transactions per flying hour
- 10.45 item records per flying hour

ANNEX 1

MEASURES OF MISSION CAPABILITY

MEASURES OF MISSION CAPABILITY

This paper provides a compilation of ways the Air Force addresses, measures, and quantifies its mission. The purpose of this list is to identify a set of measures that would be fruitful to pursue in terms of their relationship to various BOS workload measures and BOS manpower.

The measures identified can be classified in several ways:

- Measures can either be absolute standards of performance (mission standards), or they can be performance reports of how well units compare to various standards (mission performance measures).
- Capabilities can reflect peacetime requirements, wartime requirements, or they can measure readiness (the capability of a unit to make the transition from peacetime to wartime employment).
- Measures can be direct mission performance indicators or they can be indirect or secondary indicators that are assumed to be correlated with some aspect of mission performance.

The measures of mission capabilities identified are grouped accordingly:

- Primary mission standards
- Primary mission performance standards
- Secondary standards and performance measures of potential use
- Secondary performance measures of no potential use

Primary Mission Standards

Designed Operational Capability (DOC) Statement [1]. This formal statement, as formulated by MAJCOMs, identifies the unit's wartime requirements to accomplish 100% of its mission and contains quantitative descriptions of the unit's tasked mission, including sortie rates and duration. This statement could serve as a useful standard for quantifying wartime mission requirements in terms of sorties and flying hours.

Training Sorties Required [2]. Aircrews must regularly meet proficiency goals. These peacetime proficiency flying requirements theoretically reflect a unit's capability to perform its wartime mission. To meet proficiency levels for mission-ready and mission-capable status, aircrews must perform specified numbers of sorties in different categories. Sortie types depend on the type of aircraft. Some classes found were air-ground, mission support, day and night, and air combat training. This standard could serve as a basis for relating peacetime flying hour/sortie requirements to wartime mission.

Primary Mission Performance Measures

Unit Capability Measurement System (UCMS) [1]. UCMS is the standard USAF management information system to assess unit capabilities to sustain combat operations for 30 days. It contains the unit commander's daily evaluation of his unit's readiness in terms of key measures in equipment, crews, personnel, and overall readiness. Each rating is given a score ranging from 0 to 100. UCMS ratings can be converted to C-ratings. This report can provide empirical data on how well units are performing against the DOC statement.

Force Status Reports (FORSTAT) [1]. FORSTAT is a daily report to JCS on the combat readiness of units overall and in key areas, such as personnel, equipment/supplies, equipment readiness, and training. The C-rating criteria are C-1, fully ready; C-2, substantially ready; C-3, marginally ready; and C-4, not ready. The FORSTAT ratings are derived from the UCMS data previously described. The FORSTAT system is projected to be replaced by the Unit Status and Identify Report on 1 February 1980 [5].

Operational Readiness Inspections (ORI) [2]. ORIs periodically rate force readiness. Actual effectiveness data are collected by on-site inspection and functional evaluation. Aircrew and munition crew performance are measured in terms of such criteria as sorties flown, refuelings, strike events, weapons firing, day target, night target, and side-looking air-borne radar performance. All units are evaluated against standard applicable criteria.

Mobility Readiness Plans and Exercises. AFM 28-40 [4] and TAC Manual 400-1 [5] set mobility requirements and COMTAC Force Generation Publication 200 sets time frames for deployment of force packages. IG teams, ORIs, and MEI reports evaluate units according to mobility capabilities, training, and readiness criteria. The degree to which readiness plans and exercises define supply requirements, training, operationally ready equipment, and maintenance provides a potential means of relating mission readiness to BOS.

Management Effectiveness Inspections (MEI) [2]. MEIs rate units as either satisfactory or unsatisfactory under peacetime assumptions. Each functional area is evaluated under a variety of inspection criteria, and rated either laudatory, minor deficiency, or major deficiency. Functions evaluated include Personnel, Administration, Security Police, Comptroller, Weather, Organizational Maintenance, Intermediate Maintenance, and Supply.

Operational Readiness Rates [6]. Status reports document individual unit ability to provide operational aircraft (or missiles) sufficient to satisfy sortie and alert requirements of all kinds. The Aerospace Vehicle Inventory, Status and Utilization Reporting System reports mission equipment status in terms of mission capability. That is, whether they are: fully mission capable (FMC), partially mission capable (PMC), or not at all mission capable because of deficiencies in maintenance performed (NMCM), supplies required but not on hand (NMCS), or both (NMCB). This classification replaced the previous "not operationally ready due to supply (NORS) or maintenance (NORM)" classification system. Classification is based on peacetime standards of maintenance, supply, and personnel utilization. Such data could provide a means for linking actual aircraft readiness to actual maintenance and supply conditions.

Proportions of Mission-Ready Crews [2]. Assigned aircrews are evaluated against the sortie training requirements for mission-ready crews. The proportion of assigned crews meeting these standards is one description of the peacetime mission readiness of a base. This measure

is subject to considerable variability if a squadron is undergoing conversion, or is serving as a replacement training squadron.

Secondary Standards and Performance Measures of Potential Use

Flying Activity [7, 8]. Measures such as sorties per month, flying hours per month, and sorties/flying hours per aircraft can serve as quantifiable measures of mission capability and activity. These activity-level measures should be related to specific training or combat requirements, however.

Pilot Experience Levels [2]. The experience levels of pilots could serve as a general measure of pilot capabilities and hence mission capability. Pilot flying hour experience can be broken down according to several categories, such as combat experience, and by aircraft. It is probably not useful as the primary measure of mission, but it could provide additional empirical data on how pilot flying time and sortie experience are likely to be distributed.

Sortie Event Content [2]. Related to the number and types of training sorties is the event content of each sortie. There are TAC and general AF standards that must be met by each sortie. Event content might serve as a secondary factor for projecting flying hours based on sortie types.

Mission Manpower Authorizations by UE. This is used as an overall descriptive measure to assess manning ratios and support efficiencies of similar units [2]. Manpower was classified as required by wing, fighter squadron, maintenance, and support elements. While not useful directly as a measure of mission capability, if organizational components manpower requirements per UE are reliable, that information could be used as one element of information in estimating population-related support requirements.

Direct Maintenance Manhours per Flying Hour (DMMH/FH) [9]. DMMH/FH is proposed as a measure of flying hours as they relate to maintenance man-hours. The actual observed man-hours can vary in the short run due

to the urgency of sortie generation, deferred maintenance, and on-the-job training [2]. Such relationships can be useful to the GEBOS model, but GEBOS should probably rely on derived DMMH/FH factors, rather than short-term statistical observations.

Defense Resource Model (DRM) [10]. DRM was developed by GRC for the Congressional Budget Office to describe the budget impact of DOD requirements. The model is driven by force changes in primary aggregated elements (Strategic and Tactical/Mobility forces). These changes in turn drive changes in other areas such as auxiliary activities, mission support, central support, and miscellaneous through a series of linear, hierarchical relationships. While not a standard or performance measure as such, DRM methodology might be adapted for projecting BOS manpower as a function of mission unit force structure.

Secondary Performance Measures of No Potential Use

Maintenance Experience [2]. One intermediate measure of maintenance capabilities is the average years of experience of maintenance personnel. Theoretically, experienced technicians will be able to perform a greater variety of maintenance tasks more efficiently. This measure is not relevant for GEBOS purposes.

Abort Rates [2]. Related to the level of operations is the number of missions aborted. It could serve as a measure of maintenance-aircrew proficiency. However, abort rates observed by Morgan and others were usually low with little explainable variability.

Base Self Sufficiency Indices [2]. Such indices reflect the ability of units to accomplish field and intermediate maintenance with their own resources. While a potentially useful index, it is usually quite high and appears to have too little variability for GEBOS analysis purposes.

Accident Rates [2]. Accident rates could be a measure of pilot and training proficiency. Observed values found there was little explainable variation that could be directly related to training or mission capabilities.

Proposed Analysis Plan

Figure 1 is a conceptual display of the proposed BOS mission extension. BOS manpower requirements are based on peacetime BOS workload. One reason for this is that in wartime the emergency work week will increase available manhours by approximately 68%.¹ Also, many BOS workload factors are population- rather than usage-related. For these reasons, there is an implicit assumption that peacetime BOS manpower for a given installation will support its wartime workload (to include deployment commitments). Thus, the next key activity in determining the relationship of BOS manpower and mission capability is the analysis of the impact of peacetime mission demands on BOS workload.

Several aspects of peacetime mission capability should impact on BOS workload factors. Mission personnel clearly will contribute to population-related workload that drives Administration, MWR, and Other Base Services manpower requirements. Other peacetime mission capability measures will drive other workload indicators. Flying hours and sorties flown should determine aviation fuel consumption, a key supply indicator. Other mission requirements will contribute to vehicle inventories and supply inventory and transactions. Thus, mission capability can be seen as a contributor to both mission manpower-related and mission activity-related portions of BOS workload.

Extension of BOS workload-BOS peacetime mission requirements can make GEBOS a useful programming tool as well as an explanatory model. Model users can input various mission requirements in terms of aircraft by model-design-series and a utilization rate. The model-design-series can then be used to generate various fixed mission manpower and BOS support (such as supply inventory requirements) data and the programmed utilization rate, in such terms as flying hours, sorties and/or alert lines will generate additional activity-related supply requirements. These total requirements can then determine BOS manpower requirements using production function and constraint relationships similar to those of the existing model.

¹Wartime projected available manhours 244 per month versus 144.9 current.

BOS - MISSION CONCEPT

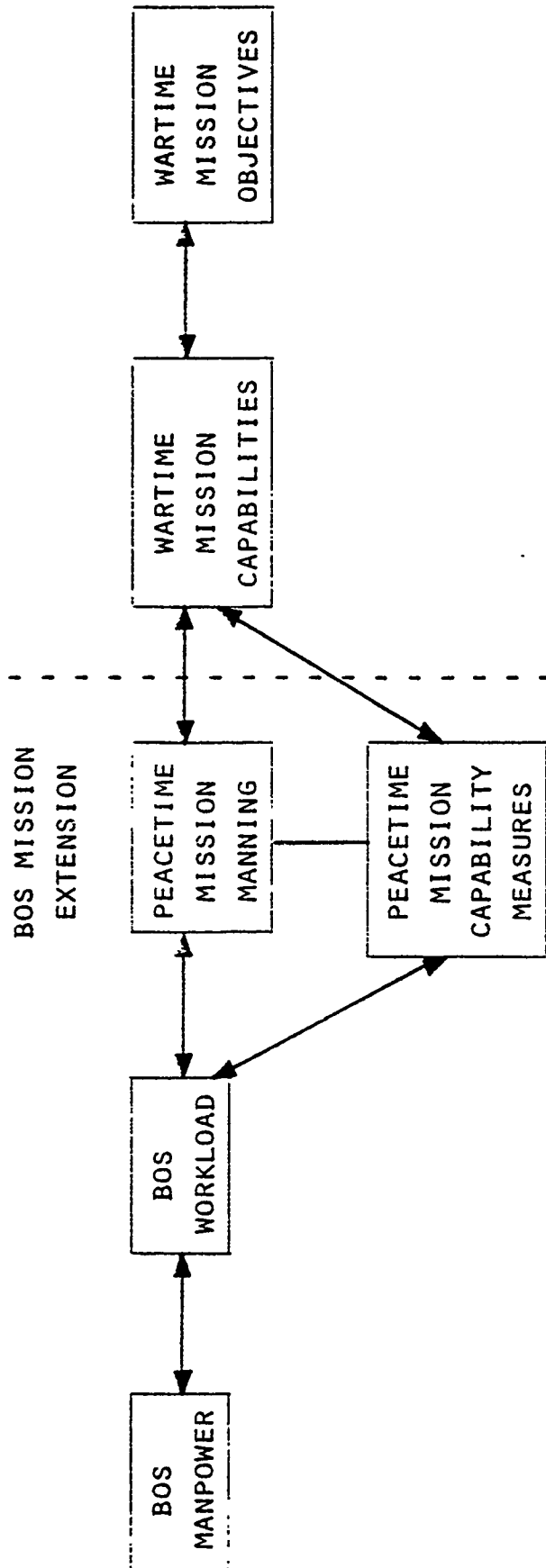


Figure 1. Proposed BOS Mission Extension

The final step in determining the impact of BOS changes is the investigation of the relationship between peacetime mission capabilities and wartime mission capabilities and objectives. Flying hours and peacetime sortie requirements are necessary to maintain pilot and crew proficiency. These training requirements relate to their ability to perform wartime missions of various types and with particular frequency. These wartime mission capabilities will determine what mission objectives the crews can be expected to accomplish. It should then be possible to make quantified statements about the impact of BOS changes on peacetime activity and force levels and the relationship which these changes, in turn, have on wartime capabilities.

During the remainder of the current effort, major research concentration will be focused on establishing relationships between peacetime mission activity and BOS workloads and the development of a prototype or demonstration capability to predict BOS requirements by functional grouping as a function of changes in force levels and activity rates.

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